DMT
DANISH MYO TECHNOLOGY

MYODYNAMICS MUSCLE STRIP MYOGRAPH SYSTEM

MODEL 840MD

User Manual

Version 1.1

MYODYNAMICS MUSCLE STRIP MYOGRAPH SYSTEM
MODEL 840MD

TRADEMARKS

PowerLab® and LabChart® are registered trademarks of ADInstruments Pty Ltd. The names of specific recording units, such as PowerLab 4/35, are trademarks of ADInstruments Pty Ltd.

Danish Myo Technology A/S reserves the right to alter specifications as required.
This document was, as far as possible, accurate at the time of printing.
Changes may have been made to the software and hardware it describes since then.
New information may be supplied separately.

This documentation is provided with the
Model 840MD– Version 1.0

No part of this document may be reproduced by any means without
the prior written permission of Danish Myo Technology A/S.

Copyright © Danish Myo Technology A/S

CONTENTS

Trademarks **3**
Safety **5**
Unpacking the myograph system **6**

Chapter 1 - System overview **7**
1.1 MyoDynamics Muscle Strip Myograph System - 840MD front panel 7
1.2 MyoDynamics Muscle Strip Myograph System - 840MD rear panel 7
1.3 MyoDynamics Muscle Strip Myograph chamber 8

Chapter 2 - Setting-up **9**
2.1 The complete MyoDynamics Muscle Strip Myograph System - 840MD 9
2.2 Setting up step-by-step 9
2.3 The first weight calibration 10

Chapter 3 - The Interface Menus **11**

Chapter 4 - Calibration of the force transducer **20**
4.1 Force transducer calibration procedure 20

Chapter 5 - protocol Command **21**
5.1 Example 1 21
5.2 Example 2 25
5.3 Digital Input 26
5.4 Digital Output 26

Chapter 6 - Checking the force transducer **27**
6.1 Force Transducer Replacement: 27

Chapter 7 - Myograph Maintenance **29**

Chapter 8 – Mounting **31**
8.1 Muscle mounting in the 840MD chamber 31
8.2 How to change the pins (figure 8.3) 32
8.3 How to adjust the jaws after replacing (figure 8.3) 32

Appendix 1 - Principles of weight calibration **33**
Appendix 2 - Reading a millimetre micrometer **35**
Appendix 3 - Protocol schedule **36**
Appendix 4 - System specifications **37**
Appendix 5 - EC Declaration of Conformity **38**

Notes **39**

SAFETY

The 840MD has been designed for use only in teaching and research applications. It is not intended for clinical or critical life-care use and should never be used for these purposes; nor for the prevention, diagnosis, curing, treatment, or alleviation of disease, injury, or handicap.

- Do not open the unit: the internal electronics pose a risk of electric shock.
- Do not use this apparatus near water.
- To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture. Objects filled with liquids should not be placed on the apparatus.
- Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.
- Only use secure industry standard connectors and tubing for pressure connections. Faults, defects and mistakes due to wrong connections void warranty. We are not liable for errors and mistakes due to inappropriate pressure connection.
- Do not install near any heat sources such as radiators, heat registers, stoves, or any other apparatus that produces heat.
- Only use attachments and accessories specified by the manufacturer.
- Unplug this apparatus during lightning storms or when unused for long periods of time.

The 840MD is delivered with an external 100-240V AC to 24V DC ADAPTER. Protect the power ADAPTER and cord from being walked on or pinched. Particularly at power plugs and at the point where they connect to the apparatus.

Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, including: the power-supply cord or plug being damaged, liquid spilling onto or objects falling into the apparatus, exposure to rain or moisture, abnormal operation, or the unit being dropped.

UNPACKING THE MYOGRAPH SYSTEM

Take a few minutes to carefully inspect your new 840MD for damage which may have occurred during handling and shipping. If you suspect any kind of damage, please contact DMT immediately and the matter will be pursued as soon as possible. If the packing material appears damaged, please retain it until a possible claim has been settled.

We recommend that you store the packing material for any possible future transport of the 840MD. In case of transport and the original packing material is unavailable, please contact DMT Sales Department for advice and packing instructions.

After unpacking your new Myograph System, please use the following list to check that the system is complete:

- 1 interface unit
- 4 chamber units with mounted clamp supports
- 4 chamber covers
- 1 external temperature probe
- 1 power cord*
- 1 calibration kit (including bridge, balance and 10 g weight)
- 1 tube of high vacuum grease
- 1 tube of grease for screw thread
- 2 Allen keys
- 1 small screwdriver
- 1 CD with an user manual for Muscle Strip Myograph System

** The shape of the AC plug varies by country; be sure that the plug fits the outlets for your location.*

CHAPTER 1 - SYSTEM OVERVIEW

1.1 MyoDynamics Muscle Strip Myograph System - 840MD front panel

Figure 1.1 *- Interface front panel with 840MD chambers*

1.2 MyoDynamics Muscle Strip Myograph System - 840MD rear panel

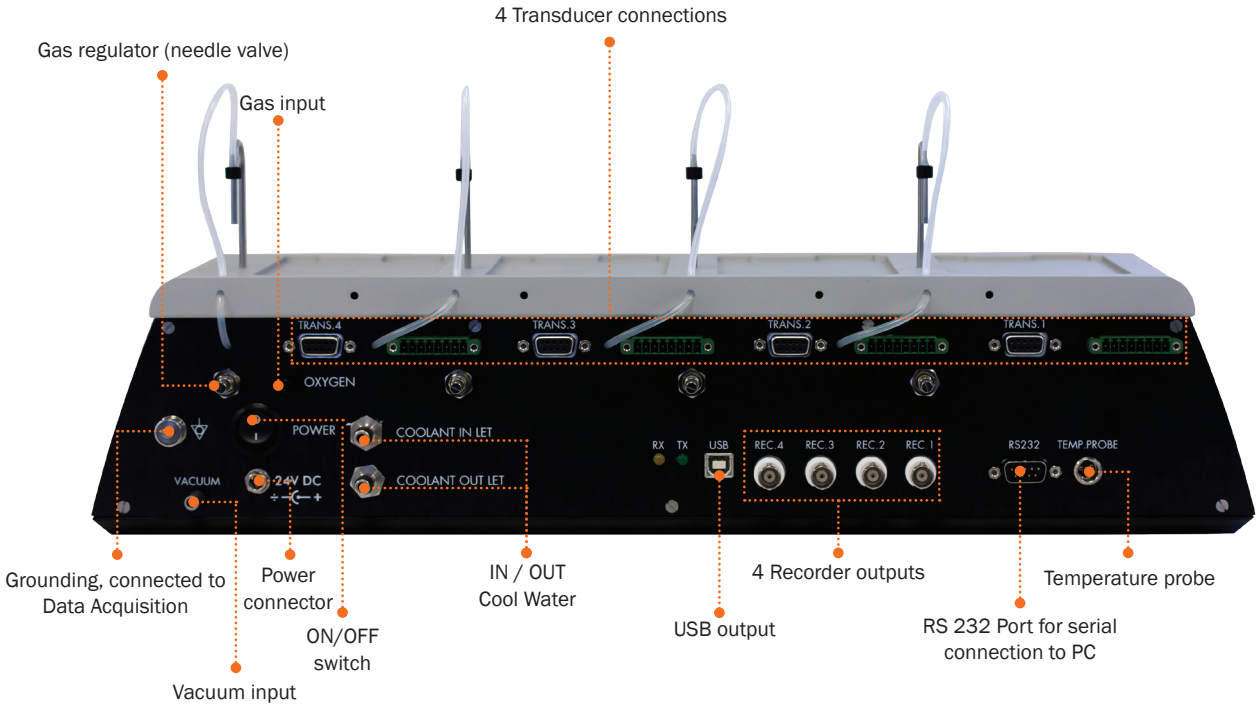


Figure 1.2 *Interface rear panel*

1.3 MyoDynamics Muscle Strip Myograph chamber

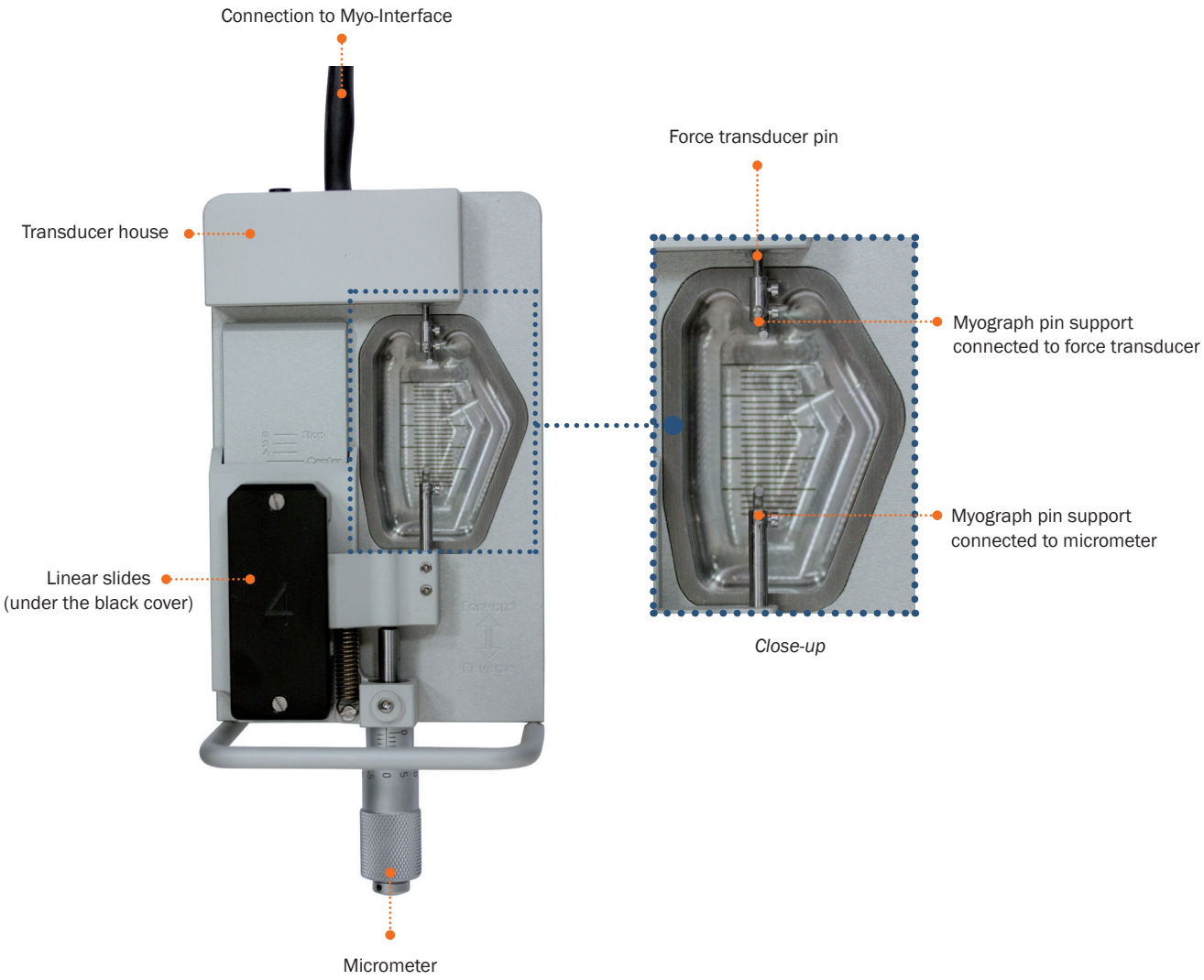


Figure 1.3 *MyoDynamics Muscle Strip Myograph chamber*

CHAPTER 2 - SETTING-UP

2.1 The complete MyoDynamics Muscle Strip Myograph System - 840MD

Connection to oxygen supply
Vacuum pump (optional)
Suction bottle (optional)
Interface rear panel (close-up)
BNC Cables
PC USB connection
PowerLab data acquisition system (optional)
Pulse/Train Stimulator CS200 (optional)
USB cable
PC data acquisition and analysis software (optional)
Chamber cover with built-in electrodes (one for each chamber, optional item)

Figure 2.1 *The complete MyoDynamics Muscle Strip Myograph System - 840MD*

2.2 Setting up step-by-step

This chapter contains a complete step-by-step description of how to set up a 840MD system as illustrated in figure 2.1.

Interface
Data acquisition is possible by connecting the Interface to a PowerLab data acquisition and analysis system (optional).

PowerLab (optional)
Connect the Interface to the PowerLab unit using BNC cables. Connect Rec 1 on the Interface to Input 1 on the Power Lab, Rec 2 to Input 2, etc. Connect the PowerLab unit to one of the USB-ports on the PC using the USB cable supplied with the PowerLab system. Follow the “DMT Quick-Start Guide” provided with the PowerLab system to install the PowerLab driver and Chart software on the PC.

Oxygen Supply
Connect the gas supply (95% O_2, 5% CO_2 or 21% O_2, 5% CO_2, balance NO_2) with tubing running from the gas supply to the gas inlet on the back of the Interface. Oxygen is supplied to the chambers by tubing attached to the stainless steel vacuum pipes. The oxygen and vacuum tubing need to be inserted into the chamber in order to aerate the heated buffer. Needle valves on the back of the interface can be adjusted to regulate the amount of bubbling that occurs. Turning these regulators clockwise increases the bubbling while turning them counter-clockwise decreases the bubbling. Each regulator has a lock device incorporated that can be set when the desired bubbling is achieved.

NOTE: THE NEEDLE VALVES NEED TO BE GREASED (USING THE SUPPLIED LINEAR-SLIDE GREASE) AND TURNED AT REGULAR INTERVALS TO PREVENT THEM FROM STICKING OR PERMANENTLY FREEZING.

Vacuum Connection
The system has a built-in manifold with separate valves that allows each chamber to be drained individually. After connecting the vacuum source at the back of the Interface, the vacuum pipes need to be inserted into the chambers in order for this feature to work properly. The pipes are inserted into the chamber by gently pulling up on the curved part of the pipe, turning it 90° counterclockwise and gently lowering it into the chamber (figure 2.2). A chamber can then be emptied by pressing the corresponding numbered button. Pressing the "all" button will empty all the chambers at the same time.

NOTE: WHEN DRAINING THE CHAMBERS USING THE AUTOMATIC VACUUM FUNCTION, PRESS THE APPROPRIATE BUTTON FOR AN ADDITIONAL 3-5 SECONDS AFTER THE INITIAL EMPTYING. THIS WILL HELP CLEAR RESIDUAL BUFFER RETAINED IN THE TUBING AND VALVES.

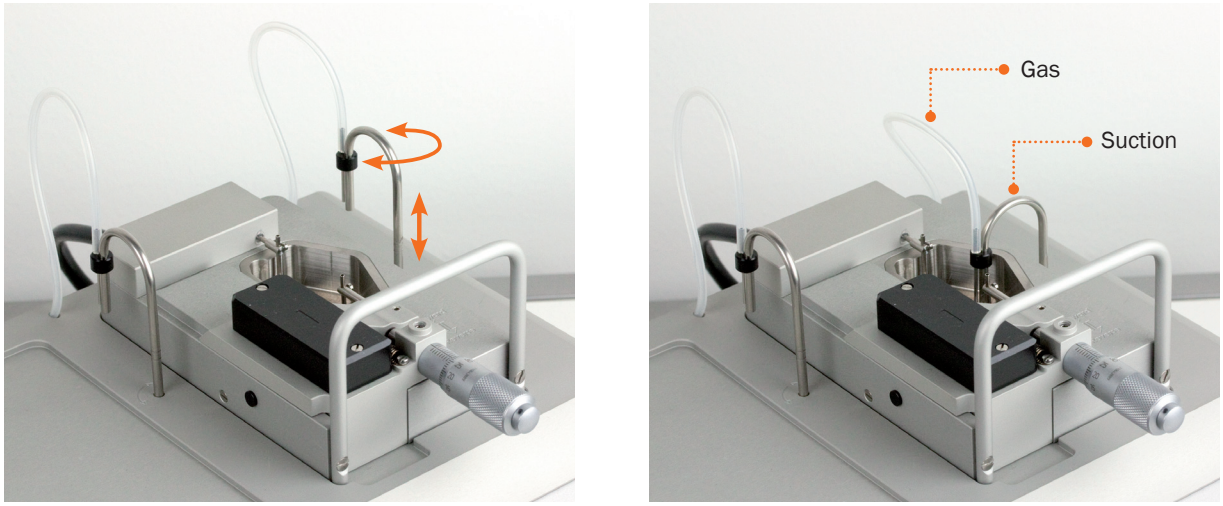


***Figure 2.2** - Oxygen supply and suction connection*

Chamber covers
The chamber covers will help to maintain the temperature and other buffer conditions (gas tension, pH). Holes in the chamber covers serve different purposes, illustrated in figure 2.3. The slots allow the covers to be placed over the chamber around the support arms and gas/vacuum tubes.

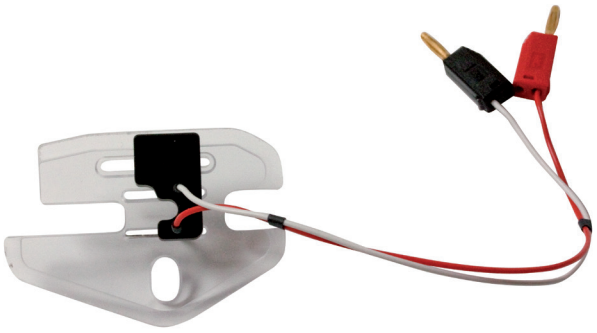


***Figure 2.3** - Chamber cover with built-in electrodes (optional item)*

2.3 The first weight calibration

Prior to shipment the 840MD System is subjected to two days of continuous testing, including a final weight calibration. However DMT recommends that a new weight calibration is performed before using the myograph system for the first time. The weight calibration procedure is described in detail in the FORCE CALIBRATION sub-menu under SETTINGS, as explained in chapter 3.

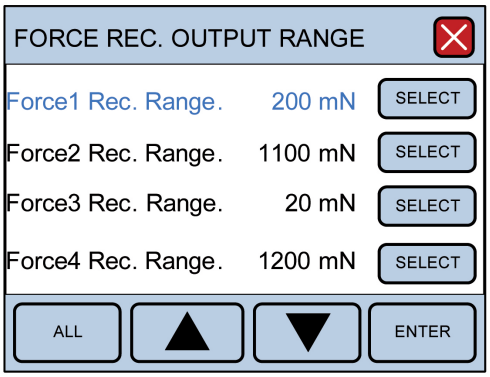
CHAPTER 3 - THE INTERFACE MENUS

Chapter 3 is a complete manual for the 840MD Interface. The chapter contains a detailed description of how to navigate the touch screen menus and how to use the special features of the 840MD.

Menus on the 840MD interface are all accessible by the touch screen. To access a menu, simply touch the screen to access a menu. When a setting needs to be changed, the setting can be changed by pressing the “SELECT” button on the touch screen that corresponds to the channel you wish to change.

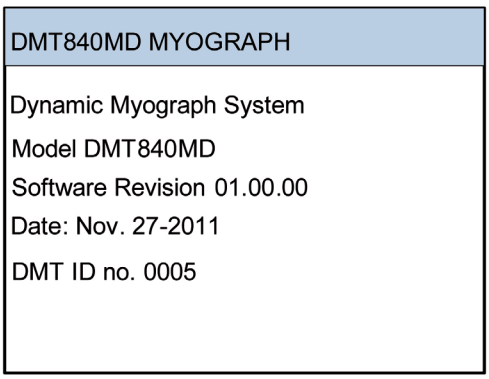
The line to be modified will turn blue, indicating that the interface is waiting for input. When “ALL” is chosen, all lines corresponding to all 4 channels will turn blue. Changing the numeric value for the chosen parameter can be done by touching the up or down arrow keys.

Once the desired setting has been chosen, pressing “ENTER” will lock the selection and store it in the memory. Pressing the white “X” in the red box will exit that menu and take you automatically to the Actual Force display.

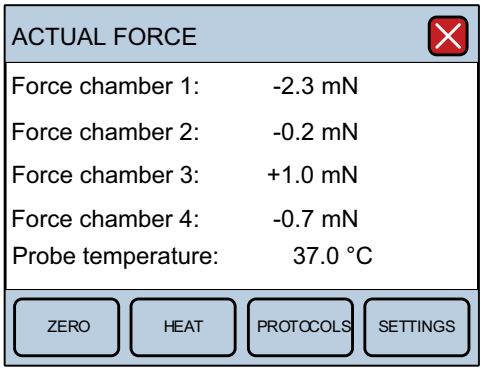


Power-Up Screen
After turning on the 840MD Interface, an “Introduction” screen appears. It displays the software version number and the system ID number.

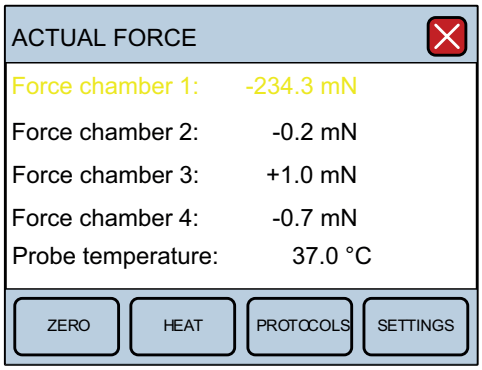
The system is auto-initialising while this screen is displayed.



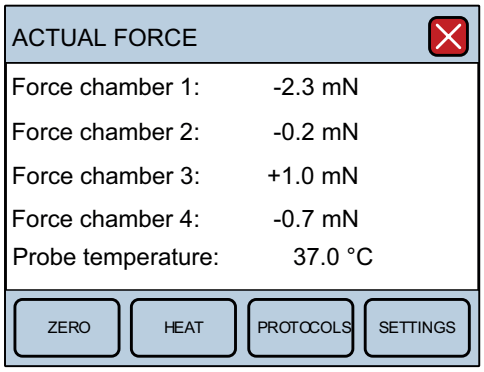
After a few seconds, the “ACTUAL FORCE” display will appear.



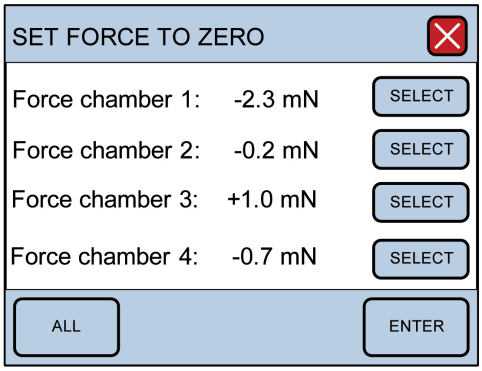
At any given time, if the force applied on any channel is out of range, the force reading for the overloaded channel will turn yellow as a warning.



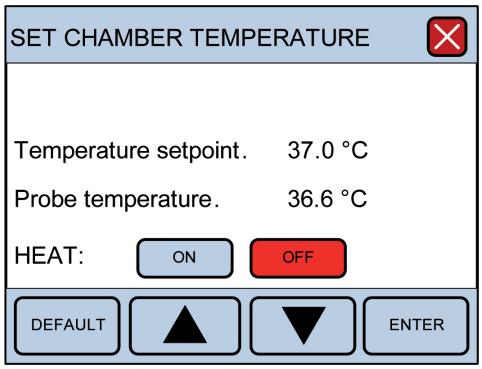
Force menus are accessible from the default “Actual Force” screen. These menus are: Zero, Heat, Protocols and Settings.



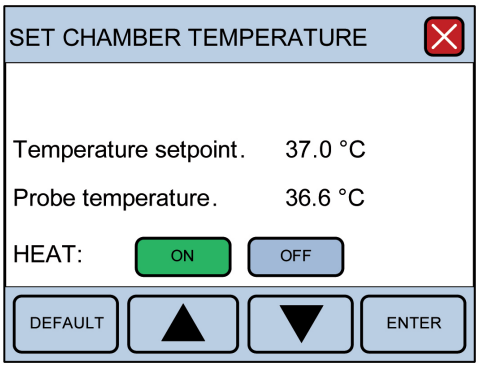
ZERO MENU:
This menu is used to zero the output of the transducers. When using a data acquisition program like LabChart by AD Instruments ®, this feature will reset the baseline of the Chart traces without affecting any calibrations or physically changing any pre-load tensions placed on the mounted muscle strips. The channels can be changed individually by pressing “SELECT” or all at once by pressing “ALL”. Pressing “ENTER” will execute the zero function.



HEAT MENU:
The heating unit and temperature are controlled from this menu. To turn the heat on or change the preset temperature for the system, access the temperature control menu. Pressing the “HEAT” button will enter the menu and allow the user to change the default system temperature, as well as turn the heat on or off. Pressing “DEFAULT” will automatically reset the temperature setpoint to 37 °C. Manually change the temperature by pressing the up or down arrows. Pressing “ENTER” will save the new temperature setpoint.



To turn the heat on, touch “ON” and the “ON” icon will turn green. The system will heat to the designated temperature setpoint.

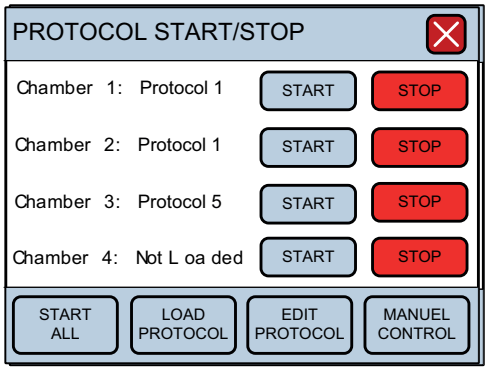


PROTOCOL MENU:
The protocols are used to control the motor in the user-defined sequences. The "PROTOCOLS" menu contains several sub-menus that can be accessed to change functional aspects of the protocols. These sub-menus include: **LOAD PROTOCOL**, **EDIT PROTOCOLS** and **MANUAL CONTROL**.

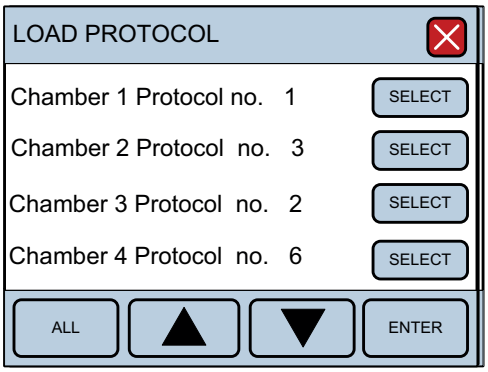
The Protocol Main Menu is used to start/stop the loaded protocols. A protocol must be loaded before it can be started. If a chamber has no protocol loaded the START command will not work, and the display will show "Not Loaded".

To start all chambers use the START ALL button. This button will then convert to STOP ALL. If only one chamber has to be started or stopped use the START or STOP button to the right of each chamber.

The START key turns green when the protocol is started. The STOP key turns red if the protocol is stopped or not loaded.



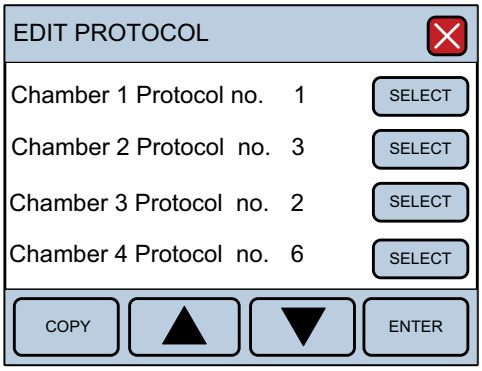
LOAD PROTOCOL SUB-MENU:
Use the "SELECT" or the "ALL" key to select which chamber to load. After selecting the chamber (the line will turn blue) the protocol number to be loaded can be changed with the arrow key. When the protocol number is selected press ENTER to upload the protocol to the motor. The line will return to black.



EDIT PROTOCOL SUB-MENU:
Use the "SELECT" button to select which chamber to edit. After selecting the chamber (the line turns blue). The protocol number to be edited can be changed with the arrow keys. When the protocol number is selected, press ENTER which will take you to the programming menu.

The protocols can be copied between the chambers. Press the COPY button to get to the COPY menu. See the COPY menu description on next page.

OBS: AFTER A PRORTOL HAS BEEN EDITED IT MUST BE RELOADED BEFORE IT GETS ACTIVE.



PROGRAMMING MENU:
A protocol can have from 1 to 30 program lines. Each program line has a number on the left hand side. After the program line number there is text that described the command. If the command includes a programmed numeric value, this will be on the right hand side of the text.

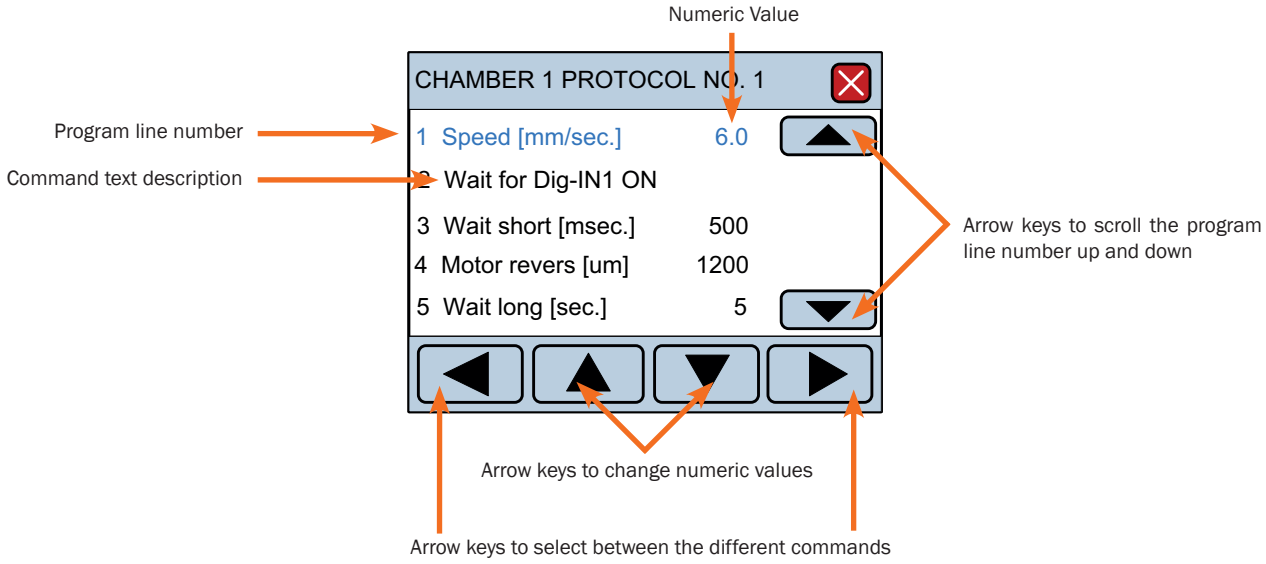
Only one line is programmed at a time. To select a line number use the scroll keys on the right hand side of the display. The selected line turns blue.

The left and right arrow keys at the bottom of the display are used to scroll between the different commands.
The arrow keys at the middle are used to change the numeric value in the command.

To save changes to a command, simply move up or down from its line.

NOTE: THE NEW COMMAND IS FIRST SAVED IN THE PROTOCOL AFTER YOU SCROLL AWAY FROM THE LINE NUMBER, SO IF IT IS LINE NUMBER 1 THAT HAS BEEN CHANGED SCROLL TO LINE NUMBER 2 TO SAVE THE NEW COMMAND IN LINE 1 TO THE PROTOCOL, AND SO ON. IT DOESN'T MATTER IF YOU SCROLL UP OR DOWN.

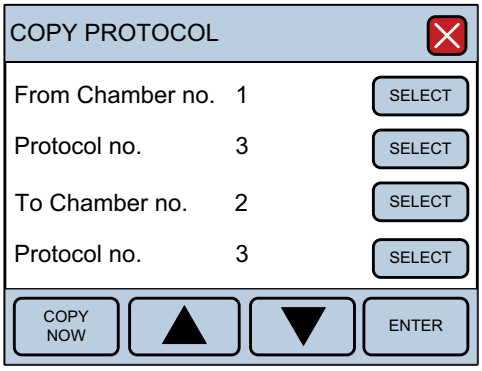
When the protocol is started it executes from line number 1. The first line is always the first command.


Numeric Value
CHAMBER 1 PROTOCOL NO. 1
Program line number
Command text description
1 Speed [mm/sec.] 6.0
2 Wait for Dig-IN1 ON
3 Wait short [msec.] 500
4 Motor revers [um] 1200
5 Wait long [sec.] 5
Arrow keys to scroll the program line number up and down
Arrow keys to change numeric values
Arrow keys to select between the different commands

COPY MENU:
protocols can be copied between the chambers to reduce programming time. Before a copy can take place it has to be configured.
Use the SELECT button to select the line that must be changed. The line turns blue.
Use the arrow keys to change the numeric values. Press ENTER to save the selected value.

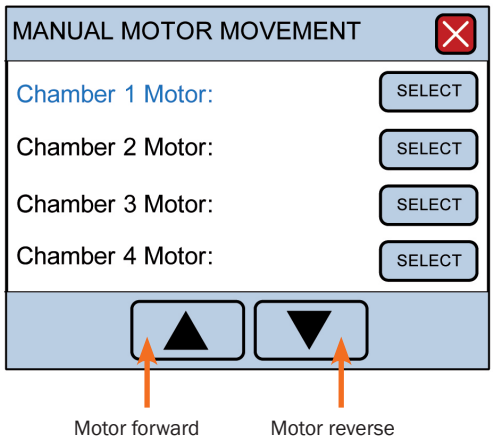
When the configuration of chambers and protocols is correct, press the COPY NOW button. The display will indicate the status of the copy.

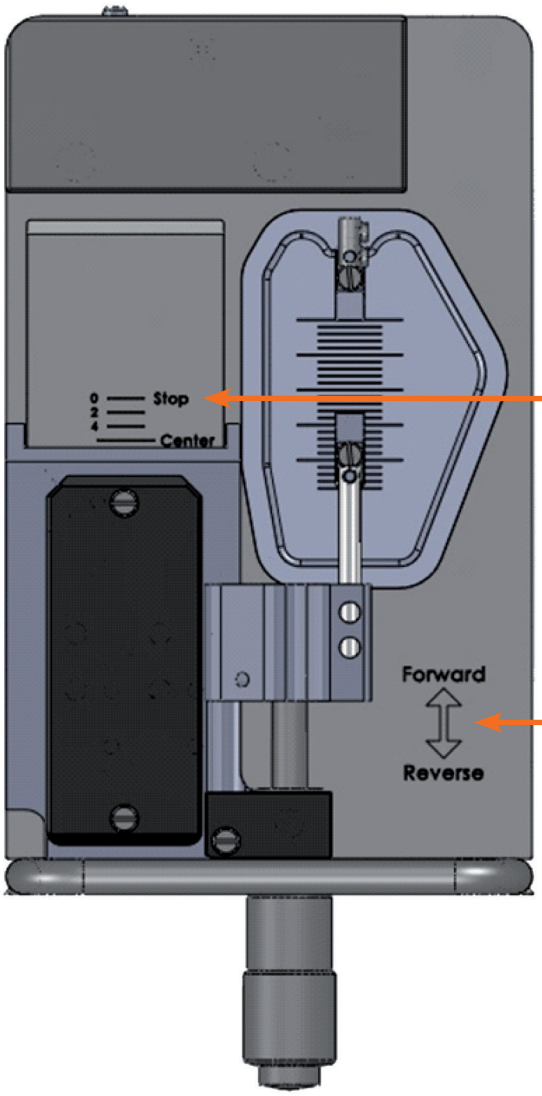
NOTE: BE CAREFUL WHEN USING THE COPY FUNCTION THERE IS NO REGRET FUNCTION.



MANUAL CONTROL MENU:
Use the “SELECT” button to choose which chamber to control. After selecting the chamber the line turns blue. The motor position can be changed with the arrow key.

A quick press on the arrow key make the motor move 10µm. If the arrow key is pressed constantly, the motor speed will accelerate.

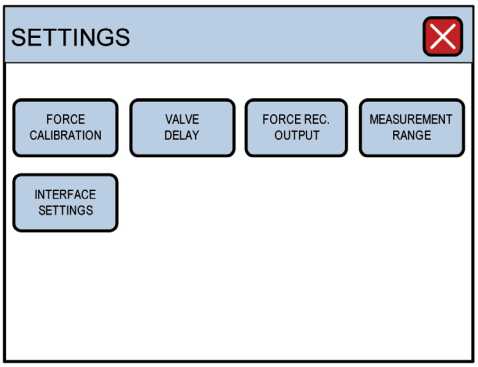




Maximum travel is marked with a STOP line.

Motor direction - forward/reverse

SETTINGS MENU:
The “Settings Menu” contains several sub-menus that change functional aspects of the interface. These sub-menus include: FORCE CALIBRATION, VALVE DELAY, FORCE REC. OUTPUT, MEASUREMENT RANGE and INTERFACE SETTINGS.

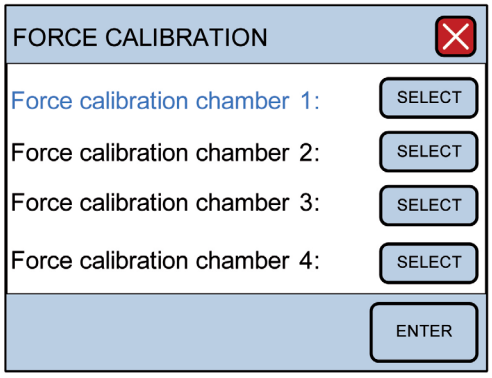


FORCE CALIBRATION:

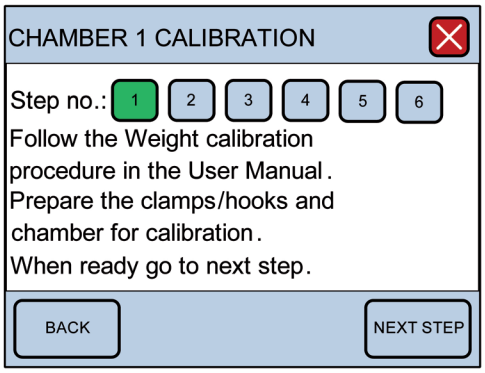
NOTE: EVERYTIME A FORCE CALIBRATION IS PERFORMED THE MEASUREMENT RANGE IS SET TO DEFAULT 200 mN. SET MEASUREMENT RANGE AFTER THE FORCE CALIBRATION.

When the FORCE CALIBRATION sub-menu begins the Transducer Calibration Procedure will start immediately. Begin the calibration procedure by pressing "FORCE CALIBRATION" to enter the sub-menu. The sub-menu will list all 4 chambers for calibration.

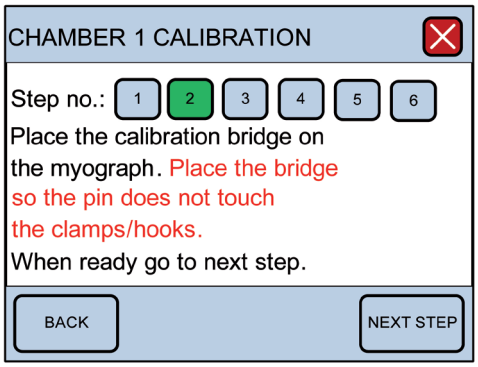
To begin the calibration, press "SELECT" for the chamber to be calibrated. The text line for the chamber will turn blue. Pressing "ENTER" will start the 6-step calibration procedure.



Step 1 - The calibration procedure consists of 6 individual steps and should be performed for each channel or transducer when calibrating the system. Step 1 involves setting up the chamber for calibration. Make sure the chamber contains the tissue clamps. Fill the chamber with double-distilled water. The volume should be the same as the volume you plan to use in your experiment. Press "NEXT STEP".


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Follow the Weight calibration procedure in the User Manual.
Prepare the clamps/hooks and chamber for calibration.
When ready go to next step.
BACK
NEXT STEP

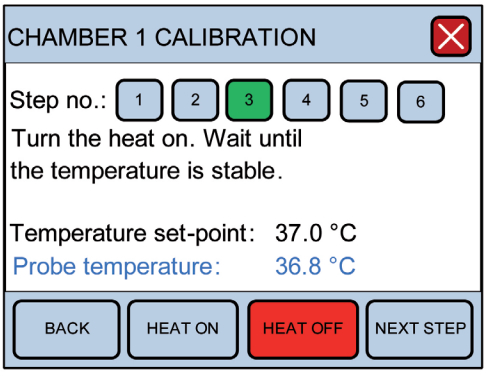
Step 2 - Involves setting up the calibration kit appropriately for the weight calibration. Verify that the calibration bridge arm does not touch the clamps. The bridge arm should be as close as possible to the clamp without touching in order to get the most accurate calibration. Press "NEXT STEP" when the calibration kit has been properly placed.


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Place the calibration bridge on the myograph. Place the bridge so the pin does not touch the clamps/hooks.
When ready go to next step.
BACK
NEXT STEP

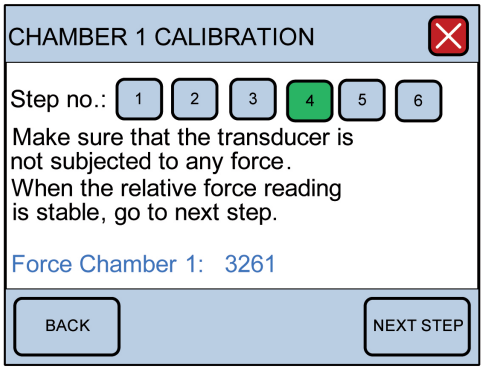
Step 3 - Initiates the heating process for the chambers. In order for the calibration to be accurate, the transducers must be heated to the same temperature as which you plan to use for your experiment. This is to accommodate heat-induced expansion of the electronic parts in the transducer. If the chambers are not allowed to stabilize at the target temperature, inaccurate readings and transducer drift may occur.
To start heating, press "HEAT ON".

Covering the chambers with the chamber covers will expedite heating.
Place the temperature probe into the chamber for the first calibration to monitor when it has reached the target temperature. With the chamber covers in place heating will take about 20 to 30 minutes for both the chambers and transducers to reach 37 °C.

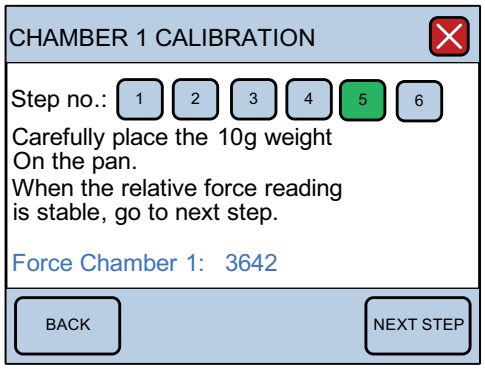
Once the chamber/chambers are heated and have reached the target temperature, press "NEXT STEP".


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Turn the heat on. Wait until the temperature is stable.
Temperature set-point: 37.0 °C
Probe temperature: 36.8 °C
BACK
HEAT ON
HEAT OFF
NEXT STEP

Step 4 - This is the first step of the weight calibration, with zero load on the transducer. A four-digit number will be displayed in blue at the bottom of the screen. If nothing has been disturbed during the heating process this zero /0 gram calibration should be stable, as indicated by the four-digit number, and “NEXT STEP” can be pressed at this time. If the four-digit number is not stable, wait until the number has stopped fluctuating before pressing “NEXT STEP”.

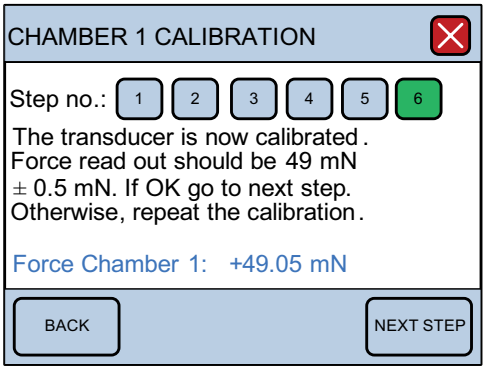

CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Make sure that the transducer is not subjected to any force.
When the relative force reading is stable, go to next step.
Force Chamber 1: 3261
BACK
NEXT STEP

Step 5 - Is the 10 gram weight calibration. At this step, place the 10 gram weight in the pan closest to the transducer (over the transducer) to simulate a muscle strip pulling on the jaw or pin attached to the transducer. Remember, a 10 gram weight in a 90° vector is cut in half, and the transducer will only detect 5 gram or 49 mN of force. The weight placement should cause a positive increase in the four-digit number. Wait at least 10 to 15 seconds for the applied force to stabilize before pressing “NEXT STEP”. Once the four-digit number has stabilized, press “NEXT STEP”.


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Carefully place the 10g weight On the pan.
When the relative force reading is stable, go to next step.
Force Chamber 1: 3642
BACK
NEXT STEP

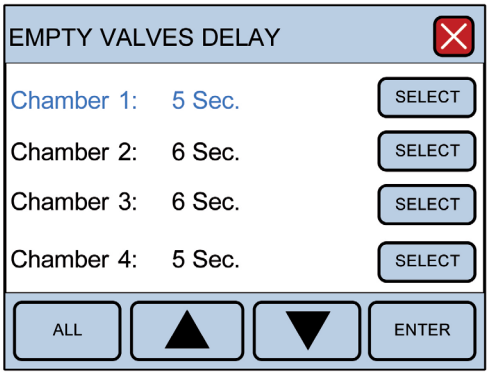
Step 6 - Is to verify that the calibration was performed correctly. The “Force Chamber 1” reading should be 49.03 ± 0.5 mN. If the “Force Chamber 1” reading is off by more than 0.5 mN, then remove the weight, press “BACK” to return to Step 4, and repeat the calibration process. If the “Force Chamber 1” reading is satisfactory, then press “NEXT STEP”.

Calibrate the other chambers in the same manner. To calibrate the transducers to a data acquisition system such as the AD Instruments PowerLab and LabChart system, see Quick-Start Guide for the 840MD.

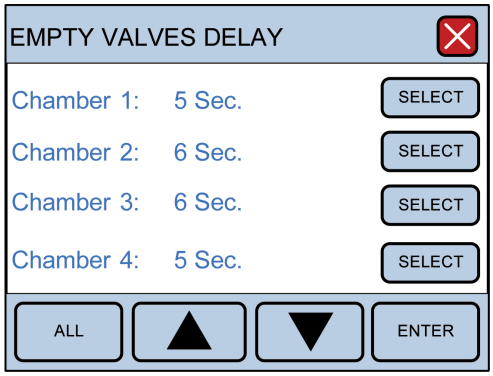

CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
The transducer is now calibrated.
Force read out should be 49 mN ± 0.5 mN. If OK go to next step.
Otherwise, repeat the calibration.
Force Chamber 1: +49.05 mN
BACK
NEXT STEP

VALVE DELAY:
Pressing “VALVE DELAY” in the SETTINGS menu will allow the user to modify the time duration that the vacuum valves stay open for chamber washes. The factory default is set at 1 second which is not enough time to completely empty a chamber with a small volume.

Pressing “SELECT” next to any given channel will cause the line selected to turn blue. The up and down arrow keys can then be used to modify the number of seconds the vacuum valves stay open when the valve buttons on the front panel of the interface are pressed.
Pressing “ENTER” will save changes to this setting.

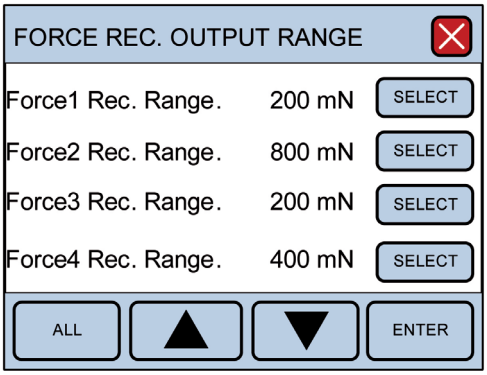


Pressing “ALL” will cause all the lines to turn blue, meaning all chambers can be modified at the same time. Again, the up and down arrow keys can be used to modify the length of time the vacuum valves stay open. Pressing “ENTER” saves the changes to these settings.



FORCE REC. OUTPUT:

The FORCE RECORDING OUTPUT, or FORCE REC. OUTPUT, sub-menu determines the upper limit for force sent from the BNC analogue output connectors. This will only affect the data collected from the interface to a data acquisition system such as AD Instruments PowerLab. The factory default setting for FORCE REC. OUTPUT is 200 mN, meaning that if the force of the mounted muscle strip exceeds 200 mN, the force recorded in the data acquisition software will not be more than 200 mN. The software will show a flat-line trace at 200 mN, even though the force readings on the 840MD Interface display may exceed 200 mN. Therefore, change the FORCE REC. OUTPUT settings to an adequate value that it may capture any response from the muscle strip of interest.



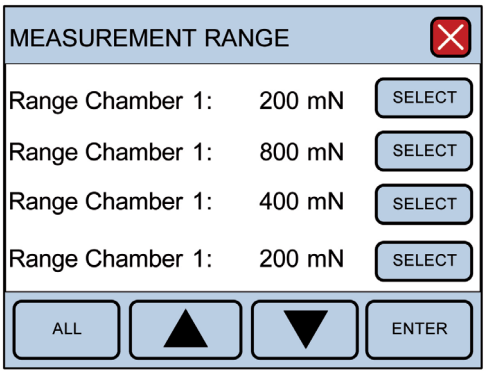
This value should not exceed the settings for the transducer range, which is defined by the sub-menu, MEASUREMENT RANGE and is explained in the next section.

The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will save the settings for future experiments.

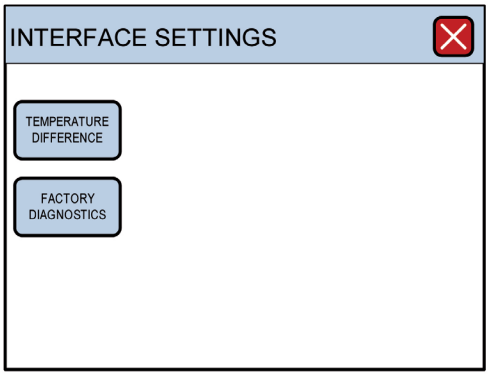
Any time this setting is changed, a new weight calibration on the transducers should be performed, entering the new voltage values into the data acquisition system being used.

MEASUREMENT RANGE:

The MEASUREMENT RANGE sub-menu in SETTINGS determines the maximum force capacity of the transducer. The factory setting is 200 mN, but the transducer capacity can be changed to 400 mN, 800 mN or a maximum of 1600 mN of force detection, depending on the size of the muscle strip used. The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will save the settings for future experiments.

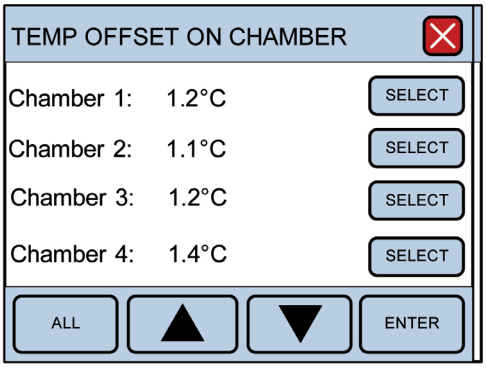


INTERFACE SETTINGS:
The INTERFACE SETTINGS sub-menu in SETTINGS has an additional two sub-menus. These are: TEMPERATURE DIFFERENCE and FACTORY DIAGNOSTICS.

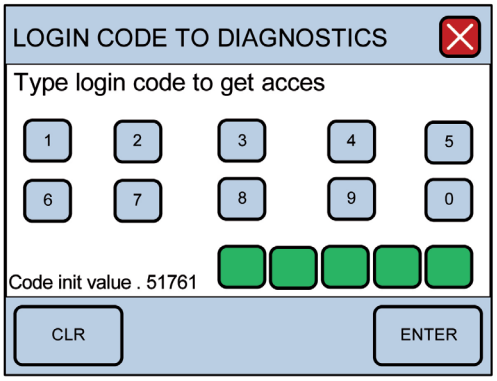


TEMPERATURE DIFFERENCE:
The TEMPERATURE DIFFERENCE setting allows the user to fine-tune the temperature setpoint of the system. Although the temperature set-point for the system can be set in the HEAT MENU, the actual temperature for the system may not heat to the exact setpoint. Therefore, the user can adjust the temperature of each chamber individually to fine-tune the temperature setting so that EXACT temperatures can be achieved. This is referred to as a temperature offset (TEMP OFFSET ON CHAMBER).

The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will save the settings for future experiments.



FACTORY DIAGNOSTICS:
Selecting FACTORY DIAGNOSTICS will display the LOGIN CODE TO DIAGNOSTICS window. This window is for trained technicians and used for diagnostics and troubleshooting purposes. The general user will not have access to this window. Entering the proper five-digit pin code will allow a trained technician to access information during a malfunction.



CHAPTER 4 - CALIBRATION OF THE FORCE TRANSDUCER

As a part of the general maintenance of the myograph, DMT recommends that the myograph is weight calibrated at least once a month. The myograph should also be weight-calibrated every time the interface has been moved. Although lab benches are supposedly perfectly horizontal, small differences in lab bench pitch can affect the calibration of the system. The myograph should also be calibrated if the system has been idle for longer than a month. A step-by-step procedure is included in the FORCE CALIBRATION sub-menu under SETTINGS, as explained in chapter 3. See appendix 1 for Principles of Weight Calibration.

4.1 Force transducer calibration procedure

This section contains step-by-step instructions to calibrate the force transducer and should be used in conjunction with the steps described in chapter 3 (FORCE CALIBRATION sub-menu under SETTINGS).

NOTE: EVERYTIME A FORCE CALIBRATION IS PERFORMED THE MEASUREMENT RANGE IS SET TO DEFAULT 200 mN. SET MEASUREMENT RANGE AFTER THE FORCE CALIBRATION.

1. Move the pins apart. Fill the chamber with distilled water or buffer. Use the same volume that will be used during the experiments.

2. Set up the calibration kit (bridge and balance) on one of the myograph chambers as illustrated in figure 4.1 Also place the weight on one of the chambers. Turn the heat on as discussed in chapter 3.

3. The system takes about 20 to 30 minutes to reach 37 °C. Higher temperatures take longer to reach. Allow adequate time so that calibration can be performed at the temperature you plan to use in your experiment. Warm up the calibration kit and weight by resting them on the chamber. There is no need to bubble the chambers while waiting for the system to heat up.

4. When the system reaches the target temperature, adjust the calibration kit so that the tip of the calibration bridge arm is as close to the pin on the transducer side as possible without touching, as illustrated in figure 4.2.
   One way to do this is to use the following technique. Start with the calibration kit in place so that the arm of the calibration bridge with the pans is not touching any part of the pin. Go to the main menu displaying the forces, and zero the channel being calibrated so the force reads zero. Slowly and gently slide the calibration kit forward toward the micrometer so that the calibration bridge arm rests on the pin, creating a force reading on that channel.

   Carefully slide the calibration kit back toward the transducer slowly until the force reads zero or very close to zero. At this point, as soon as the force reads zero, the calibration bridge arm will be properly placed for weight calibration.

5. Go to the FORCE CALIBRATION sub-menu of the SETTINGS menu on the Interface to begin the transducer calibration. The process that has been described in detail in chapter 3 is displayed in 6 steps once the FORCE CALIBRATION sub-menu is initiated.

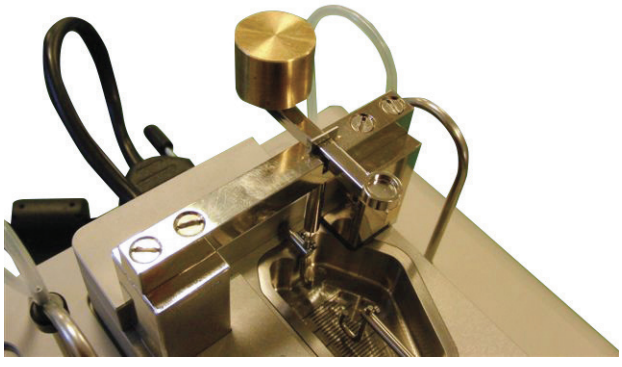


Figure 4.1 *- Weight calibration kit shown in place on a single myograph chamber*

Figure 4.2 *- Illustration of the proper placement of the bridge arm for calibration*

CHAPTER 5 - PROTOCOL COMMAND

At the moment there are 16 different commands to choose from when making the protocol.

Command shown in the 840MD display	The function of the command
Stop	This is the default command in all protocols when not programmed.
1. Protocol End	The protocol execution is stopped, until a new manual start is done.
2. Wait for Dig-IN1 ON	Wait until the digital input 1 is active “On” before the next protocol line is processed.
3. Wait for Dig-IN1 OFF	Wait until the digital input 1 is inactive “OFF” before the next protocol line is processed.
4. Wait for Dig-IN2 ON	Wait until the digital input 2 is active “On” before the next protocol line is processed.
5. Wait for Dig-IN2 OFF	Wait until the digital input 2 is inactive “OFF” before the next protocol line is processed.
6. Set Dig-OUT1 ON	Set the digital output 1 ON. Active (low impedance).
7. Set Dig-OUT1 OFF	Set the digital output 1 OFF. Active (high impedance).
8. Set Dig-OUT2 ON	Set the digital output 2 ON. Active (low impedance).
9. Set Dig-OUT2 OFF	Set the digital output 2 OFF. Active (high impedance).
10. Speed [mm/sec.]	Speed range on motor 0,5-12 mm/sec.
11. Motor forward [µm]	Forward movement of the motor with the clamps moving together - range is 10 to 5000 µm.
12. Motor reverse [µm]	Reverse movement of the motor with the clamps moving away - range is 10 to 5000 µm.
13. Wait long [sec.]	Wait a long time before next line is processed, range is 1-5000 sec.
14. Wait short [msec.]	Wait a short time before next line is processed, range is 10-10000 msec.
15. Jump to line	Jump to line no. And execute the protocol from the new line - range is 1-30
16. Repeat	How many times the protocol has to be repeated. The range is 1 to 250 times.

5.1 Example 1

This is an example of how to program a protocol.

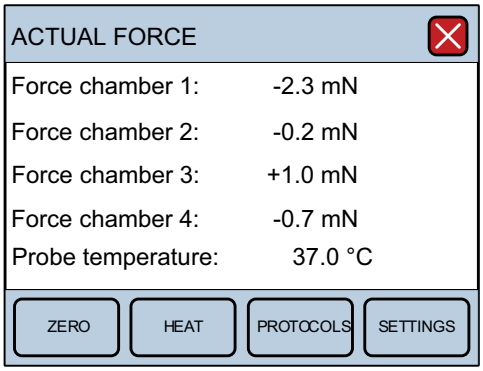
Step 1 - Start with filling out the protocol schedule as shown here.

Chamber no. 1 **Protocol no. 1**

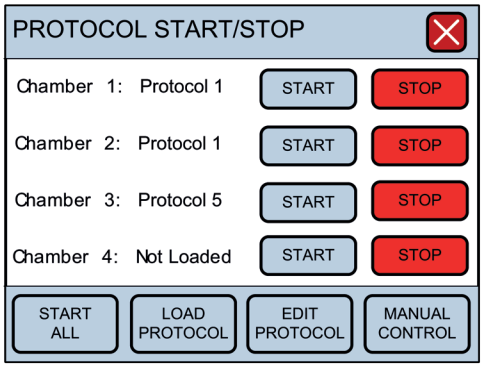
Line no.:	Command:	Value:
1	Speed [mm/sec.]	7.5
2	Motor reverse [µm]	100
3	Wait long [sec.]	3
4	Motor forward [µm]	100
5	Wait long [sec.]	3
6	Motor reverse [µm]	30
7	Wait short [msec.]	100
8	Motor forward [µm]	30
9	Wait long [sec.]	1
10	Repeat	10
11	Jump to line	2
12	Protocol End	
13		
14		
15		

Protocol example 1 *- A typical protocol can look like this.*

Step 2 - Open the protocol display by pressing the PROTOCOLS button.



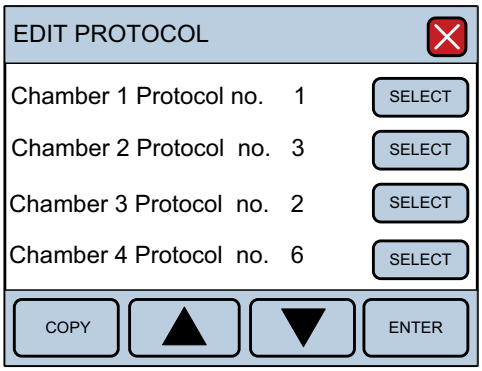
Step 3 - Open the edit protcol display by pressing the EDIT PROTOCOL button.



Step 4 - Select Chamber 1 with the SELECT button. The text line turns blue when selected.

Use the arrows to select the protocol number.

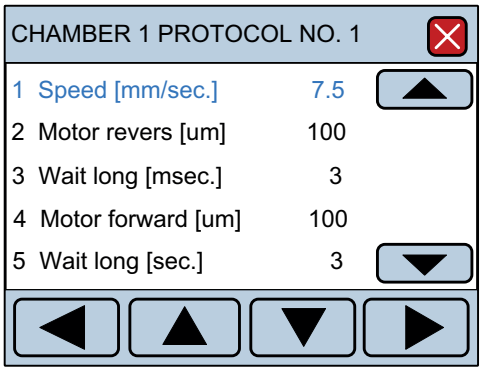
Pres the ENTER button to go to the programming menu.



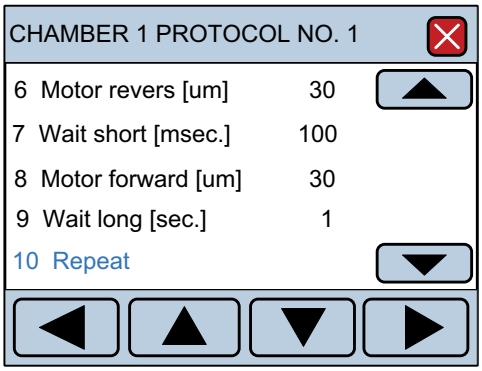
Step 5 - The display must look like this after the protocol is programmed.

Look in chapter 3 under Programming Menu: for a description on how to navigate the display.

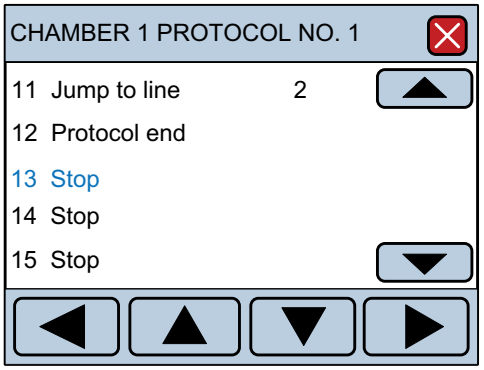
Program no. 1-5



Program no. 6-10

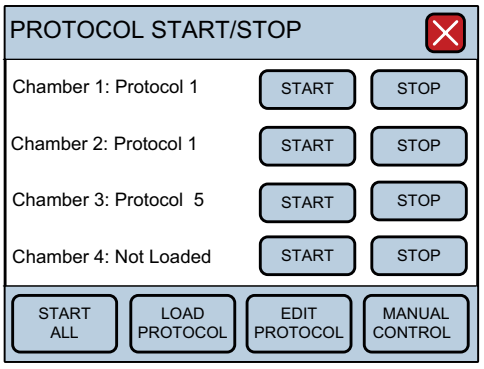


Program no. 11-15



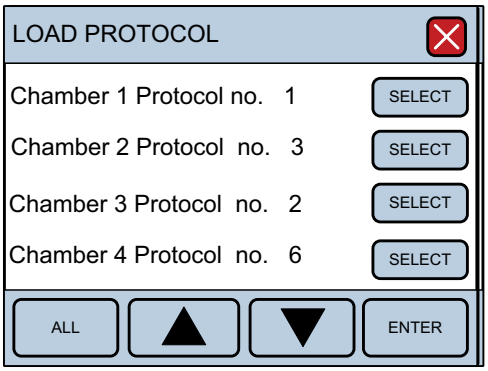
Step 6 - After programming, press on the red cross to return to Protocol menu.

Step 7 - To load the program press the LOAD PROTOCOL button.

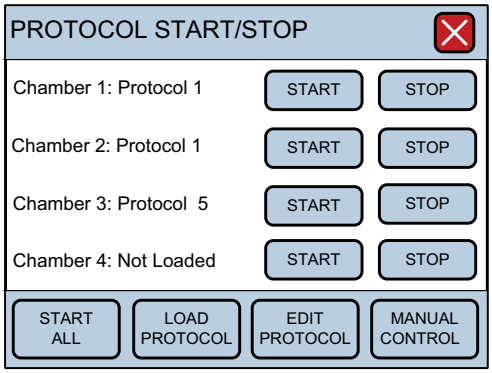


Step 8 - Select Chamber 1 with the SELECT button. The text line turns blue when selected.

Use the arrows to select the protocol number.
Press the ENTER button to load the protocol.
After loading, press the red cross to go back to the protocol start/stop display.



Step 9 - Protocol number 1 on chamber 1 is ready to start. Press the START button.



Description of protocol example 1:

This example is a simple protocol used to illustrate some of the commands.

Line 1: Speed [mm/sec.]	Set the speed on the motor to 7.5mm/sec. The speed must be set before the motor is started.
Line 2: Motor reverse [µm]	Set the distance the motor has to move away from the transducer to 100 µm.
Line 3: Wait long [sec.]	Wait 3 sec. before the next command line is executed.
Line 4: Motor forward [µm]	Set the distance the motor has to move towards the transducer to 100 µm.
Line 5: Wait long [sec.]	Wait 3 sec. before the next command line is executed.
Line 6: Motor reverse [µm]	Set the distance the motor has to move away from the transducer to 30 µm.
Line 7: Wait short [msec.]	Wait 100 msec. before the next command line is executed.
Line 8: Motor forward [µm]	Set the distance the motor has to move towards the transducer to 30 µm.
Line 9: Wait long [sec.]	Wait 1 sec. before the next command line is executed.
Line 10: Repeat	Repeat the protocol 10 times.

NOTE: AFTER A "PROTOCOL" COMMAND, THERE MUST ALWAYS BE A " JUMP TO LINE" COMMAND.

Line 11: Jump to line	Set the line number (2) the repeat command will be restarted on.
Line 12: Protocol End	Stop the execution of the protocol.

The protocol is ready for a new manual start from the display.

After programming (Editing) the protocol, it is ready to be loaded into chamber 1. After loading, the protocol is ready to start.

NOTE: AFTER A PROTOCOL HAS BEEN EDITED IT MUST BE RELOADED BEFORE IT IS ACTIVE.

5.2 Example 2

Chamber no. 1 **Protocol no. 4**

Line no.:	Command:	Value:
1	Speed [mm/sec.]	3.2
2	Wait for Dig-IN1 ON	
3	Motor reverse [µm]	100
4	Wait long [sec.]	3
5	Motor forward [µm]	100
6	Wait long [sec.]	3
7	Set Dig-OUT1 ON	
8	Motor reverse [µm]	30
9	Wait short [msec.]	100
10	Motor forward [µm]	30
11	Wait long [sec.]	1
12	Set Dig-OUT1 OFF	
13	Repeat	10
14	Jump to line	2
15	Protocol End	

Protocol example 2 *- A typical protocol can look like this.*

Description of protocol example 2:
This is a more complex example with an external digital start trigger. It can be a start pulse from a stimulator or some other external device.

It also uses the digital output which can be used to trigger the data acquisition system or some other external device.

Line 1: Speed [mm/sec.] Set the speed on the motor to 3.2mm/sec. The speed must be set before the motor is started.
Line 2: Wait for Dig-IN1 ON The program is waiting on the digital input 1 to go ON (be active).
Line 3: Motor reverse [µm] Set the distance the motor has to move away from the transducer to 100 µm.
Line 4: Wait long [sec.] Wait 3 sec. before the next command line is executed.
Line 5: Motor forward [µm] Set the distance the motor has to move towards the transducer to 100 µm.
Line 6: Wait long [sec.] Wait 3 sec. before the next command line is executed.
Line 7: Set Dig-OUT1 ON Set the digital output ON (Low impedance).
Line 8: Motor reverse [µm] Set the distance the motor has to move away from the transducer to 30 µm.
Line 9: Wait short [msec.] Wait 100 msec. before the next command line is executed.
Line 10: Motor forward [µm] Set the distance the motor has to move towards the transducer to 30 µm.
Line 11: Wait long [sec.] Wait 1 sec. before the next command line is executed.
Line 12: Set Dig-OUT1 OFF Set the digital output OFF (High impedance).
Line 13: Repeat Repeat the protocol 10 times.
Line 14: Jump to line Set the line number (2) the repeat command will be restarted on.
Line 15: Protocol End Stop the execution of the protocol.

The protocol is ready for a new manual start from the display.

5.3 Digital Input

On each chamber backplate there is a connector with two digital inputs. The inputs are galvanically isolated from the 840MD internal power supply. The power to activate the inputs must be delivered from an external device. The voltage required to activate the input is from 5 to 24 volt DC. Each input channel is bidirectional.
The input impedance is 1.2 Kilo Ohm.
The minimum pulse length that can be detected is 5 ms.

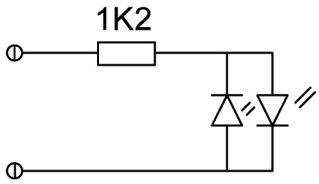


Diagram of the
Digital input

5.4 Digital Output

At the backplate of each chamber is a connector with two digital outputs. All the outputs are galvanically isolated from the 840MD internal power supply.
Each output channel is bidirectional and works like a Relay.
The maximum voltage at the output is 24 volts.
The output impedance is 120 Ohm.
The minimums pulse length at the output is 10 ms.

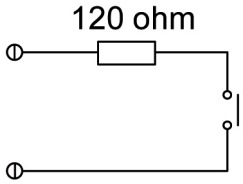
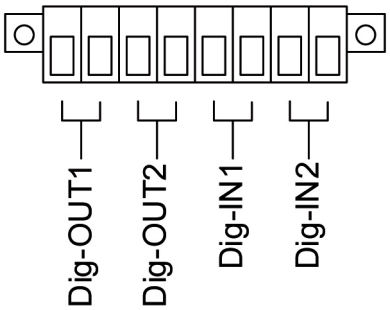


Diagram of the
Digital output

Connector at the backplane



CHAPTER 6 - CHECKING THE FORCE TRANSDUCER

The myograph force transducer is a strain gauge connected to a Wheatstone bridge. The force transducers for each chamber are housed in a separate, protective compartment (see figure 6.1). While the protective cover offers some mechanical protection for the force transducers, they are still very vulnerable to applied forces exceeding 2 Newton (200 grams) or fluid running into the transducer compartment due to insufficient greasing of the transducer pinhole. If the force readings on the Interface appear unstable or noisy, then first check that the chambers are connected properly to the Interface and that the chambers are plugged all the way into the Interface. If the force reading(s) are still unstable or noisy, then perform a new calibration of the force transducer as described in chapter 3. During the new calibration, monitor the relative force reading values in the FORCE CALIBRATION sub-menu on the Interface (Steps 4 of the calibration procedure). The normal operating values for the force transducer during calibration should be between 3000 and 3500.

- If the value is 0, a single digit, or a three digit number, the force transducer is broken and needs to be replaced.
- If the value is less than 2000 or greater than 4500, the force transducer is broken and needs to be replaced.
- If the message “OFF” is displayed on the main page of the Interface, even though the chamber is plugged in at the rear of the interface, the force transducer is broken and needs to be replaced. In addition, if the force reading(s) appear yellow in color, cannot be reset to zero, AND the transducer cannot be recalibrated, the force transducer is broken and needs to be replaced.

If any other problems related to the force transducer are encountered, please contact DMT for advice or further instructions.

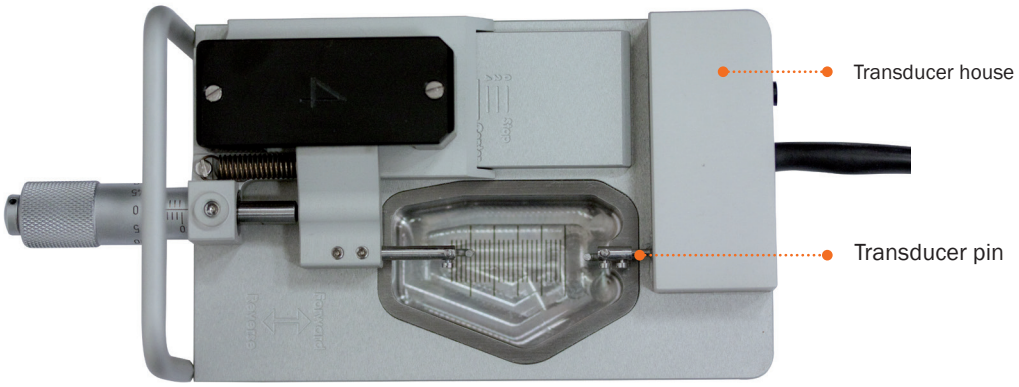


Figure 6.1 *- Illustration of the transducer housing and transducer pin*

6.1 Force Transducer Replacement:

If the force transducer breaks and needs to be replaced, follow this step-by-step replacement procedure carefully:

1. Remove the pin from the transducer pin coming out of the transducer housing (see figure 6.1).
2. Disconnect the Myograph Chamber from the Interface.
3. Turn the Myograph Chamber upside down and remove the bottom plate by loosening and removing the screws as illustrated in figure 6.2.
4. Disconnect the connector to the transducer.
5. Remove the two transducer screws that hold the transducer housing.
6. The replacement transducer will be shipped with the new transducer inside a new transducer housing.
7. Place a small amount of vacuum grease (clear or whitish grease) around the bottom of the transducer housing to seal the transducer housing when put back in place.

8. Carefully realign the transducer housing with the new transducer on the Myograph Chamber and reinsert the Allen screws through the bottom of the Myograph Chamber.

9. Tighten the screws and place some vacuum grease around the transducer pin that protrudes from the transducer housing. Make sure that the hole is completely sealed to prevent buffer solution or water from entering the transducer housing and damaging the new force transducer.

10. Reconnect the new transducer connector.

11. Place some vacuum grease at the edge of the bottom plate. Place and tighten the bottom plates.

IMPORTANT NOTE:
CALIBRATE THE NEW FORCE TRANSDUCER BEFORE PERFORMING A NEW EXPERIMENT AS DESCRIBED IN CHAPTER 3 AND 4.

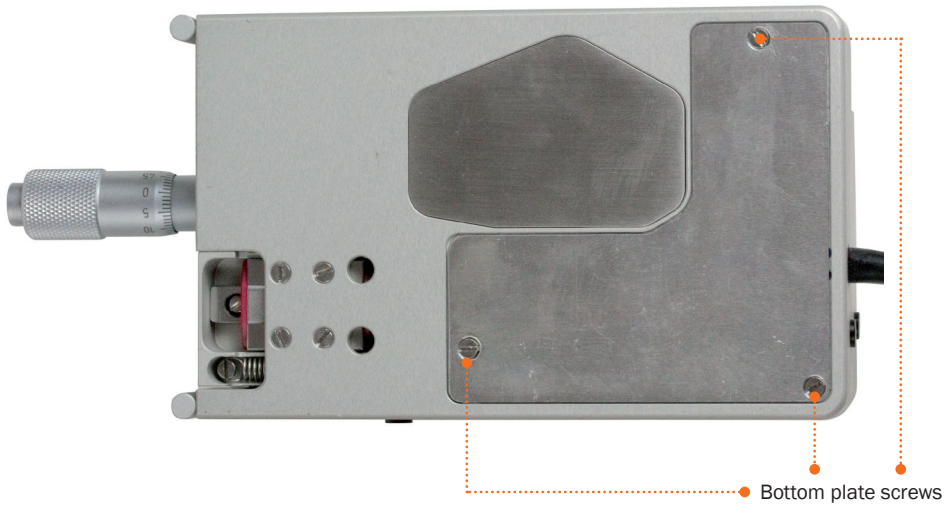


Figure 6.2 *- The screws that secure the transducer housing to the chamber.*

CHAPTER 7 - MYOGRAPH MAINTENANCE

The Myograph System Model 840MD is a very delicate precision instrument. DMT recommends that the following sections are read carefully and that the instructions are followed at all times.

Myograph chamber tubing:
To prevent the tubing from becoming blocked with buffer salt deposits after an experiment, remove the chamber cover from the Myograph Chamber and turn on the vacuum and press the vacuum valve button for about 10 seconds. Turn off the vacuum and gas supply. Remove any water or buffer remaining in the chamber or on the tubing using absorbent paper.

Force transducer:
The force transducer is the most delicate and fragile component of the myograph system. Extreme care must be used when handling or touching the force transducers. As a part of daily maintenance, inspect the grease around the transducer pin extending from the transducer housing pinhole (see figure 7.1) before starting any experiment. Insufficient grease in this area will allow buffer and water to enter the transducer housing and cause damage to the force transducer.

IMPORTANT NOTES:
DMT RECOMMENDS THAT THE HIGH VACUUM GREASE SEALING THE TRANSDUCER PINHOLE IS CHECKED AND SEALED AT LEAST ONCE A WEEK, ESPECIALLY IF THE MYOGRAPH IS USED FREQUENTLY.
DMT TAKES NO RESPONSIBILITIES FOR THE USE OF ANY OTHER KINDS OF HIGH VACUUM GREASE OTHER THAN THE ONE SUPPLIED BY DMT.
DMT TAKES NO RESPONSIBILITIES FOR ANY KIND OF DAMAGE APPLIED TO THE FORCE TRANSDUCERS.

Linear slides:
Check the linear slides (under the black covers) for grease at least once a week. In case of insufficient lubrication, grease the slides with the “Grease for Linear Slides” included with your system.

Cleaning the myograph:
DMT strongly recommends that the myograph chambers and surrounding areas are cleaned after each experiment. At the end of each experiment, use the following procedure to clean the myograph chambers and supports.

1. Fill the myograph chamber to the edge with an 8% acetic acid solution and allow it to work for a few minutes to dissolve calcium deposits and other salt build-up. Use a cotton-tipped applicator to mechanically clean all chamber surfaces.

2. Remove the acetic acid and wash the myograph chamber and supports several times with double-distilled water.

3. If any kind of hydrophobic reagents have been used which might be difficult to remove using steps 1) and 2), try incubating the chamber and supports with 96% ethanol or a weak detergent solution (i.e. 0.1% triton-100).

4. To remove more resistant or toxic chemicals, incubate the myograph chamber and supports with 1M HCl for up to 1 hour. In exceptional cases, incubate the chamber and supports with no stronger than a 3M HNO3 solution for about 15 minutes.

5. Wash the myograph chamber and supports several times with double-distilled water.

6. If acids such as 1M HCl and 3M HNO_3 are used to clean the chambers, make sure ALL surfaces are thoroughly dried after copious washes with double-distilled water. Any residual acid will cause corrosion of the stainless steel jaws and pins.

IMPORTANT NOTES:
BE VERY CAREFUL USING HCL OR HNO_3 BECAUSE THESE ACIDS MAY CAUSE EXTREME DAMAGE TO THE STAINLESS STEEL CHAMBERS AND SUPPORTS. DO NOT USE BLEACH TO CLEAN THE CHAMBERS. REPEATED USE OF CHLORINATED SOLUTIONS SUCH AS BLEACH AND HCL WILL CAUSE DAMAGE TO THE STAINLESS STEEL PARTS OF YOUR MYOGRAPH SYSTEM. AVOID USING THEM IF AT ALL POSSIBLE.

AFTER CLEANING, ALWAYS CHECK THAT THE GREASE AROUND THE TRANSDUCER PIN IS SUFFICIENT TO KEEP THE BUFFER AND WATER FROM ENTERING THE TRANSDUCER HOUSING.

If red or brown discolorations appear on the chamber sides or on the supports, the following cleaning procedure will work in most cases:

7. Incubate the myograph chamber and supports for 30 minutes with 2mM T-1210 Tetrakis- (2-pyridylmethyl)-ethylenediamine solution dissolved in double-distilled water.

8. Use a cotton-tip applicator to mechanically clean all the affected surfaces during the last 15 minutes of the incubation period.

9. Wash the myograph chamber and supports several times with double-distilled water.

10. Incubate the myograph chamber with 96% ethanol for 10 minutes while continuing the mechanical cleaning with a cotton-tip applicator.

11. Remove the ethanol solution and wash a few times with double-distilled water. Incubate the myograph chamber and supports with an 8% acetic acid solution for 10 minutes and continue the mechanical cleaning with a swab-stick.

12. Wash the myograph chamber and supports several times with double-distilled water.

13. Dry the surfaces using absorbent paper (i.e. Kim-Wipes) or cotton-tip applicators.

IMPORTANT NOTES:
IN EXCEPTIONAL CASES, THE CLAMP SUPPORTS MAY NEED TO BE REMOVED FROM THE MYOGRAPH CHAMBER AND CLEANED INDIVIDUALLY TO ASSURE PROPER CLEANING OF ALL SUPPORT SURFACES. NEVER SOAK THE SUPPORTS IN ANYTHING STRONGER THAN 8% ACETIC ACID FOR EXTENDED PERIODS OF TIME (I.E. SEVERAL HOURS OR OVERNIGHT)!

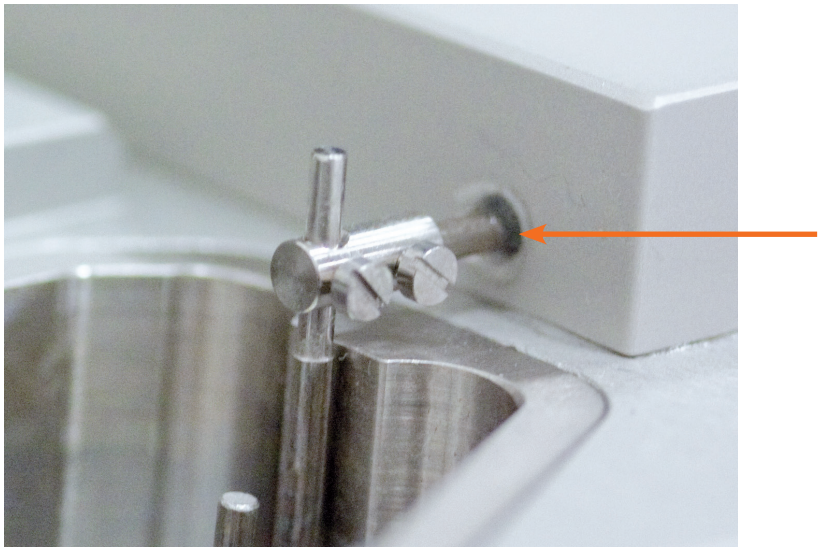


Figure 7.1 *- Close-up of transducer pin extending from the transducer housing pinhole.*

The arrow indicate the place that the grease needs to be applied to prevent water and buffer from damaging the transducer.

CHAPTER 8 – MOUNTING

8.1 Muscle mounting in the 840MD chamber

Before the muscle strips are mounted use the “Manual motor movement” menu to place the motor at the center line.

This gives the maximum movement of the motor in both “Forward and Reverse” direction.

At the chamber bottom there is a measurement scale to give a rough indication of the muscle strip length. The distance between lines is 1 mm.

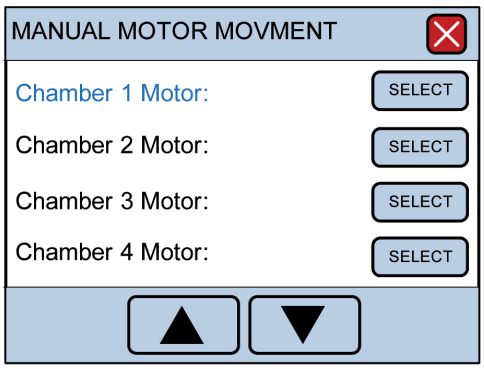


Figure 8.1 *- “Manual motor movement” menu*

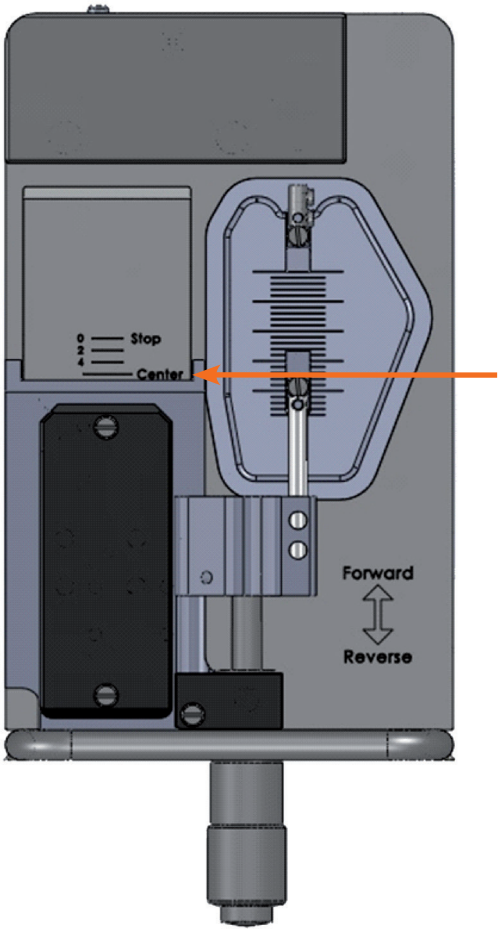


Figure 8.2 *- Center line at the chamber*

Each chamber contains supports with mounting pins to facilitate the mounting of muscle strips with sutures. DMT is also able to deliver a large variety of different mounting supports. Please contact DMT Sales to acquire more information about available mounting supports for the 840MD system.

IMPORTANT: BE VERY CAREFUL WHEN TIGHTENING THE SUTURE ON THE TRANSDUCER. EXCESSIVE PRESSURE ON THE SCREW OR EXCESSIVE TORQUE FORCE WILL DAMAGE THE FORCE TRANSDUCER.

8.2 How to change the pins (figure 8.3)

1. Use the small screwdriver provided to gently loosen screw B.
2. Gently pull the support away from the transducer pin.
3. Loosen screw A on the micrometer side with the appropriate fitting Allen key.
4. Pull the support away.

NOTE: NUMBER THE SUPPORTS WITH THE CHAMBER NUMBER THEY WERE REMOVED FROM USING SOME KIND OF PERMANENT MARKER. STORE THE SUPPORTS IN THE PROVIDED PLASTIC CASE. NUMBERING THE SUPPORTS WILL SAVE TIME WHEN THE SUPPORTS ARE REPLACED. IT WILL REDUCE THE AMOUNT OF ADJUSTMENTS REQUIRED AFTER EACH CHANGE.

8.3 How to adjust the jaws after replacing (figure 8.3)

1. Loosen screw A to move the micrometer-side pin toward or away from the micrometer.
2. Loosen screw B to move transducer-side pin toward or away from the transducer.

NOTE: BETWEEN THE BACK SIDE OF THE TRANSDUCER PIN AND THE CHAMBER WALL THERE MUST BE A SMALL AIR GAP OF 0.1 TO 0.3 MM.

3. Loosen screw C to vertically alight the transducer pin. Screw C is the screw on the transducer side support that is furthest away from the transducer.

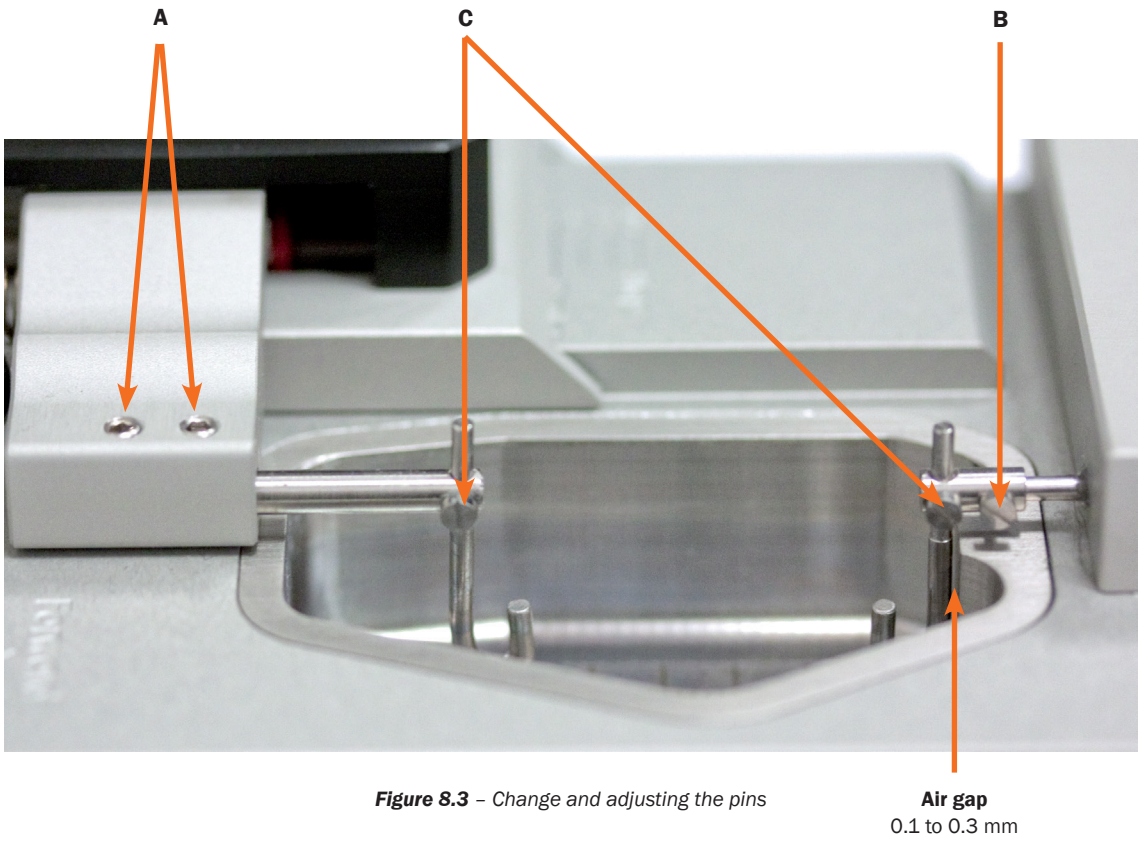
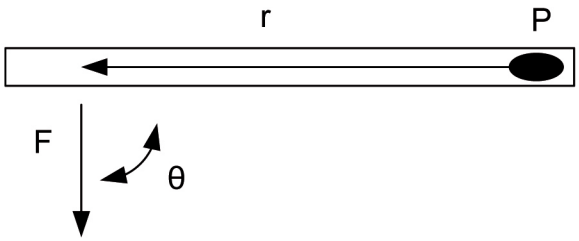


Figure 8.3 *– Change and adjusting the pins*

APPENDIX 1 - PRINCIPLES OF WEIGHT CALIBRATION

Calibrating the force transducer with a standard weight is based on simple physics where a known amount of weight acting on a balance produces a net torque. The magnitude of the torque τ about a point of rotation P is defined by:



$$\tau = r \cdot F \cdot \sin\theta$$

The distance from the point of rotation to the point on the object is denoted as “r”, where the force “F” is acting at the angle, θ. The physics of the weight calibration setup is illustrated in figure A1.1.

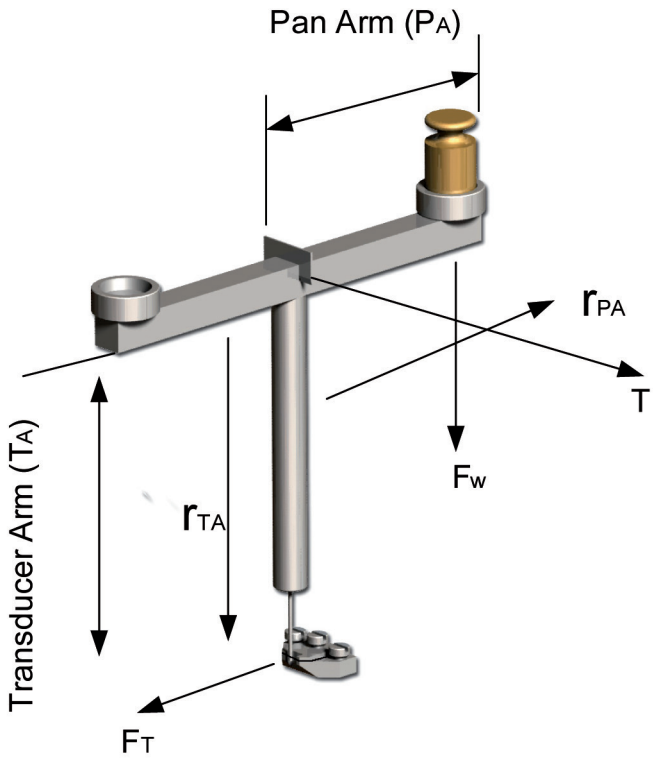


Figure A1.1 *- Theoretical principle of the weight calibration*

Applying the weight on the pan arm creates net torque acting at the “centre of gravity”, resulting in a force “FT” acting on the force transducer. The following two equations describe the forces working during the weight calibration:

1. $\tau = r_{PA} \cdot F_W \cdot \sin\theta 1 = rPA \cdot (m_{weigt} \cdot g) \cdot \sin\theta 1$

2. $\tau = r_{TA} \cdot F_T \cdot \sin\theta 2$

where “r_{PA}” is the length of the pan arm. “F_W” is the force acting on the pan arm when applying the weight. “F_W” is equal to the acceleration of gravity times the mass of the weight. The length of the transducer arm is “r_{TA}”, and the force acting on the force transducer is “F_T”.

The net torque acting at “center of gravity” is constant for the weight calibration setup. Therefore, equation 1 and 2 are equal, making it possible to calculate the force acting on the force transducer:

$r_{TA} \cdot F_T \cdot \sin\theta 2 = r_{PA} \cdot (m_{weigt} \cdot g) \cdot \sin\theta 1$

$F_T = r_{PA} \cdot (m_{weigt} \cdot g) \cdot \sin\theta 1 \,/\, (r_{TA} \cdot \sin\theta 2)$

The length of the pan arm (r_{PA}) is 2 cm, the length of the transducer arm (r_{TA}) is 4 cm, the weight is 10 g, both angles (θ1 and θ2) are 90° and the acceleration of gravity is 9.81m/s^2. Therefore, the force acting on the force transducer is:

$F_T = 2\ cm \cdot (10\ gram \cdot 9.81\ ms^2) \cdot \sin 90 \,/\, (4\ cm \cdot \sin 90)$

$F_T = 49.03\ gram \cdot m \cdot s^2$

Since 1 N is equal 1 kg · m/s^2, F_W is equal to:

$F_T = 49.03$ mN

(9.81 mN = 1.0 g.)

APPENDIX 2 - READING A MILLIMETRE MICROMETER

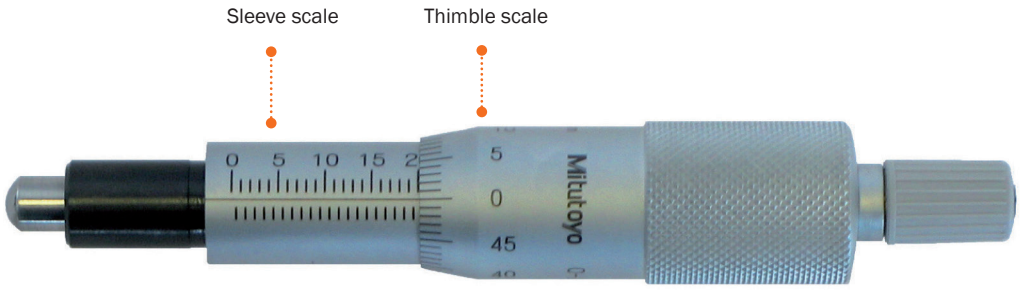


Figure A2.1 *Overview of the micrometer parts (actual reading 20000 µm = 20 mm)*

Sleeve scale

The micrometer sleeve scale has a total length of 25 mm divided into 50 equal parts. Each part of a division above the horizontal line represents 1 mm, where each 5th line is marked by a longer line and a number designating the length in mm. Each division below the horizontal line is placed between each 1 mm mark (scale above the horizontal line) and represents 0.5 mm.

Thimble scale

The thimble is divided into 50 equal parts, and one complete rotation of the thimble is indicated by the smallest division on the sleeve, which equals 0.5 mm. Each division on the thimble scale is 10 µm. If the thimble scale falls between two lines, then a number between 0 and 10 µm must be approximated.

Example 1

1. Note that the thimble has stopped at a point beyond “10” on the sleeve indicating 10000 µm (10 mm).
2. Note that there is no mark completely visible between the 10 mm mark and the thimble.
3. Read the value on the thimble corresponding to the intersection with the horizontal line on the sleeve.

A. Reading on sleeve:	10000 µm
B. No additional mark visible:	0 µm
C. Thimble reading:	380 µm
Total reading:	**10380 µm**

Figure A2.2 *Example 1: reading = 10380 µm*

Example 2

1. Note that the thimble has stopped at a point beyond “16” on the sleeve indicating 16000 µm (16 mm).
2. Note that this time a mark is visible between the 16 mm mark and the thimble indication 500 µm.
3. Read the value on the thimble corresponding to the intersection with the horizontal line on the sleeve.

A. Reading on sleeve:	16000 µm
B. One additional mark visible:	500 µm
C. Thimble reading:	280 µm
Total reading:	**16780 µm**

Figure A2.3 *Example 2: reading = 16780 µm*

APPENDIX 3 - PROTOCOL SCHEDULE

Chamber no. _____ Protocol no. _____

Line no.:	Command:	Value:
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

APPENDIX 4 - SYSTEM SPECIFICATIONS

Technical specifications

Chamber/Interface

Chamber:	Four individual chambers
Chamber suction:	Manual or automatic
Chamber cover:	Supplied with connections for gassing.
Chamber gassing:	Individually controlled per chamber
Force range:	± 200, 400, 800 or 1600 mN.
Force resolution:	0.1 mN.
Chamber size:	Standard 15ml.
Chamber material:	Stainless steel
Chamber temp. range:	15 - 40°C
Max. segmengt lenght:	23mm
Min. segmengt lenght:	2mm
Max. micrometer reach:	12mm (manual)
Max. micrometer step:	11mm (motor)
Motor speed:	0.5 – 12mm/second
Speed tolerance:	0.5%
Resolution:	0.1mm/sec.
Min. resolution of motor:	10µm
Distance tolerance:	+-15µm
Motor control:	User defined protocols
Analog outputs:	4 BNC connectors
Analog output range:	+/-2.5Volt
Output impedance:	<200 Ohm
Digital input:	Two ports on the back panel. Voltage range: 5-24VDC. Min. pulse length is 5ms. Galvanically isolated.
Digital output:	Two per chamber on the back panel. Voltage range max. 24VDC. Max. current is 30mA. Min. pulse length is 10ms. Galvanic isolated
Air connection:	Max. 10Bar
Environmental humidity:	20% to 80% RH, none condensing
Environmental operating temperature:	15-30°C
Environmental storage temperature:	4-70°C

Transducer Data

Max. range:	+-1600mN.
Operating temperature:	15 - 40°C
Frequency range:	0 – 20Hz

Active cooling with water

Amount of cooling water:	50-300ml/min.
Max. pressure:	0.5bar.
Chamber temp. resolution:	0.1°C
Chamber temp. stability:	+/- 0.2°C

Physical Data

Voltage:	100-240V AC to 24V DC +/-10%
Current maximum:	3.3Amps at 24V DC
Dimensions LxDxH:	49 x 30 x 17 cm
Net weight:	9kg.
Operating temperature:	15-30°C

Optional accessories

Automatic Buffer Filler System - 625FS
Combined pulse & train generator - CS200
Chamber cover for field stimulation

APPENDIX 5 - EC DECLARATION OF CONFORMITY

Danish Myo Technology A/S
Certify and declare that the following apparatus:

MyoDynamics Muscle Strip Myograph System - Model 840MD
Restrictive use: Only for laboratory use.

Manufactured by:
Danish Myo Technology A/S
Skejbyparken 152
8200 Aarhus N.
Denmark

Conforms with the essential requirements of the EMC Directive 2004/108/EC.
Based on the following specifications applied by:
EN 61326-1:2006
EN 61326-2-6:2006
EN 61326-2-6/Corr.:2007

And with the LVD Directive 2006/95/EC.
Based on the following specifications applied by:
EN 61010-1:2010
EN 61010-2-030:2010

General warnings regarding EMC:
Do not use this device in close proximity to sources of strong electromagnetic radiation (e.g. unshielded intentional RF sources), as these may interfere with the proper operation.

NOTES

Aalborg Hospital South • Academic Medical Center Amsterdam • Academy of Sciences of the Czech Republic • Actelion Pharmaceuticals Ltd • Ahmadu Bello University • Akzo Nobel/Organon • Albert Einstein College of Medicine • Albert-Ludwigs-Universität Freiburg • Arete Therapeutics • Aarhus Kommunehospital • Arizona State University • Asterand UK Ltd. • Aston University • AstraZeneca • AstraZeneca R&D Mölndal • Aventis Pharma • Bayer HealthCare AG • Baylor College of Medicine • Bristol-Myers Squibb • Brock University • Bulgarian Academy of Sciences • Campus Charité Mitte • Cardiff University • Case Western Reserve University • Charles University • Childrens Hospital of Pittsburgh • Chinese University of Hong Kong • Christian-Albrechts-Universität zu Kiel • Clinica Medica, PUGD Udine • CNRS d'Orléans • CNRS UMR 6097 • Columbia University • Copenhagen Hospital Glostrup • Copenhagen University • Cork University Maternity Hospital • Cornell University • Coventry University • CV Therapeutics Inc. • Cytokinetics Inc. • Daegu Catholic University • Deakin University • Der Universität Freiburg • Der Universität Im Neuenheimer Feld 326 • Deutsche Forschungsgemeinschaf (DFG), Bonn • Duke University • Duke University Pharmacology • Dundalk Institute of Technology • East Carolina University • Eastern Virginia Medical School • Ecole Polytechnique Fédérale De Lausanne • Ege University • Emory University • Emory University, School of Medicine • Erasmus Universiteit Rotterdam • Federal University of Minas Gerais • Ferring Research Institute Inc. • Florida Atlantic University • Florida International University • Forschungsverbund Berlin E.V. • Fourth Military Medical University • Franz-Volhard-Clinic • Free University Berlin • Freie Universität Berlin • Friedrich Schiller University • Fudan University • Georgetown University • Glasgow Caledonian University • Glasgow University • GlaxoSmithKline • Glenfield Hospital • Göteborg University • Grand Vally State University • Harefield Hospital • Harvard Medical School • Harvard University • Hebei Medical University • Henry Ford Health System • Hospital Clinic (Barcelona) • Hospital Lariboisiere • Hospital Ramón y Cajal (Madrid) • Hospital Universitario de Getafe (Madrid) • Hospital Universitario La Fe (Valencia) • Hospital Universitario Virgen del Rocío (Sevilla) • Humboldt Universität zu Berlin • ICBM University of Chile • Imperial College London • Indiana University • INSERM U541 • INSERM U637 • INSERM U644 • INSERM U772 College de France • Inserm U858 • Institut de Pharmacologie Moléculaire et Cellulai • Institut De Recherches Cliniques De Montréal • Institute of Cellular Biology and • Institute of Immunology & Physiology • Istanbul University • J.W. Goethe-Universität • Jagiellonian University • James Cook University • Johann-Wolfgang-Goethe-Universität • Johns Hopkins University • Juntendo University • Justus-Liebig-Universität Giessen • Kaohsiung Medical University • Karolinska Institute • KAS Glostrup • Katholieke Universiteit Leuven • King's College London • King's College London GKT School of Medicine • KK Women's and Children's Hospital • Klinikum Der Universität Zu Köln • København Universitet • Korea University • Laboratorios Almirall (Barcelona) • Linköping University • Liverpool University • Loma Linda University • Loyola University At Chicago • Ludwig Maximilians University • Lund Universitet • Lundbeck Pharmaceuticals • Luther College • M.V.Lomonosov Moscow State University • Manchester Royal Infirmary • Manchester University • Manitoba Institute of Child Health • Marquette University • Martin-Luther Universität Halle-Wittenberg • Massachusetts General Hospital • Max-Delbrück-Centrum • Mayo Clinic • McMaster University • MDC Berlin • Medical College of Georgia • Medical College of Wisconsin • Medical University of South Carolina • Memorial University Of Newfoundland • Michigan State University • Mogiglass Artigos Para Laboratorio LTDA • Monash University • Mount Sinai School of Medicine • Nanyang Technological University • Nat. Inst. Of Pharnaceutical Education & Research • National Defencse Medical Center • National Institute on Aging • National University of Ireland • NeuroSearch A/S • Neurox Pharmaceuticals LLC • New York Medical College • New York Presbytarian • North Carolina Central University • North Sichuan Medical College • Norwegian Univ Sci Tech • Novo Nordisk A/S • Ohio State University • Ono Phamaceutical Co., Ltd. • Oregon Health And Science University • Orthologic Corp. • Pathology "Nicolae Simionescu" • PDL BioPharma • Pennsylvania State University • Pfizer Ltd. • Philipps Universität • Proteon Therapeutics • Queen Mary University London • Queen's University • Queens University Belfast • Radboud University Nijmegen Medical Centre • Ranbaxy • RMIT University • Robert Gordon University • Royal College Of Surgeons In Ireland • Ruhr-Universität Bochum • Saarland University • Saint Louis University • Samsung Deutschland GmbH • Sanofi-Aventis • Shanghai Institute of Materia Medica • Skejby Sygehus, Aarhus • Slovak Academy of Sciences • SmithKline Beecham • South Florida VA Hospital • St. George's Hospital • St. Paul's Hospital • St. Thomas' Hospital, London • State University of New York • Stony Brook University • Sultan Oaboos University • Swedish Defence Research Agency, FOI • Swiss Cardiovascular Ct. Bern • Swiss Federal Institute Of Technology • Syddansk Universitet • Technischen Universität Dresden • Technischen Universität München • Temple University School of Medicine • Texas A&M University HSC • Texas Southern University • The American Cardiovascular Research Institute • The Australian National University • The Chinese University of Hong Kong • The Cleveland Clinic • The College Of William & Mary • The Edith Wollfson Medical Center • The John Curtin School of Medical Research • The Ohio State University School of Public Health • The Panum Institute, Copenhagen • The University of Alabama At Birmingham • The University of Chicago • The University of Edinburgh • The University of Hong Kong • The University of Liverpool • The University of Naples -Federico II • The University of Newcastle • The University of Queensland • The University of Sydney • The University of Texas Medical Branch • Theravance, Inc. • Tokyo Medical and Dental University, School of Medicine • Tufts University • UCL Université Catholique • UHI Millennium Institute • Ulleval University Hospital • Universidad Autónoma de Barcelona • Universidad Autónoma de Madrid • Universidad Complutense de Madrid • Universidad de Castilla-La Mancha (Albacete) • Universidad De Chile • Universidad De Murcia • Universidad de Salamanca • Universidad de Santiago de Compostela • Universidad de Sevilla • Universidad de Valencia • Universidade Do Estado Do Rio De Janeiro • Universit Milano Bicocca • Universitá Degli Studi De Torino • Universitá Degli Studi Di Brescia • Universitaet Göttingen • Universitaet Hamburg • Universität Bern • Universität Geissen • Universität Göttingen • Universität Hamburg • Universität Heidelberg • Universität Klinikum Der JWG • Universität Marburg • Universität Regensburg • Universität Rostock • Universität Tübingen • Üniversität Zürich • Universitätshospital Zürich • Universitätsklinik Essen • Universitätskliniken des Saarlandes • Universitätsklinikum Berlin • Universitätsklinikum Bonn • Universitätsklinikum Carl Gustav Carus • Universitätsklinikum Eppendorf, Hamburg • Universitätsklinikum Essen • Universitätsklinikum Münster • Universitätsklinikum Schleswig-Holstein • Universitätsmedizin Berlin-Charité • Universite Bordeaux 2 • Université catholique de Louvain • Université D'Angers • Université de Genéve • Université de Tours • Université Henri Poincaré • Université Victor Segalen • Universiteit Antwerpen • Universiteit GENT • Universiteit Maastricht • Universitetssjukhuset UMAS MALMÖ • Universitetssykehuset Nord-Norge • Universiti Brunei Darussalam • University College Dublin • University College London • University Hospital (CHUV) • University Hospital of Copenhagen - Rigshospitalet • University Hospital Zürich • University Newcastle upon Tyne • University of Aarhus • University of Alberta • University of Amsterdam AMC • University of Arizona • University of Bath • University of Bern • University ff Birmingham • University of Bonn • University of Brescia • University of Brighton • University of Bristol • University of British Colombia • University of Calgary • University of California - Irvine • University of Cambridge • University of Catania • University of Cologne • University of Colorado • University of Debrecen Inst Cardio • University of Dresden • University of Dundee • University of Edinburgh • University of Essen • University ff Exeter • University of Florida • University of Georgia • University of Glasgow • University of Göttingen • University of Groningen • University of Guelph • University of Heidelberg • University of Iceland • University of IL Urbana-Champ • University of Iowa • University of Kansas • University of Kentucky • University of Leeds • University of Leicester • University of Liverpool • University of London • University of Louisville • University of Lübeck • University of Lund • University of Maastricht • University of Malaya • University of Manchester • University of Manitoba • University of Maryland • University of Medicine and Pharmacy • University of Melbourne • University of Miami • University of Michigan • University of Missouri • University of Montreal • University of Nevada, Reno • University of New Hampshire • University of New Mexico • University of New South Wales • University of North Dakota • University of North Texas • University of Northern British Columbia • University of Nottingham • University of Osijek • University of Otago • University of Ottawa • University of Oxford • University of Padova • University of Pennsylvania • University of Pisa • University of Pittsburgh • University of Queensland • University of Rochester • University of Sao Paulo • University of Saskatchewan • University of Scranton • University of Sheffield Medical School • University of South Alabama • University of Southampton • University of St. Andrews • University of Strathclyde • University of Sunderland • University of Sydney • University of Szeged • University of Tampere • University of Texas • University of Texas Health Science Center • University of Toronto • University of Tsukuba, Graduate School of Comprehensive Human Sciences • University of Tübingen • University of Turku • University of Utah • University of Vermont • University of Virginia • University of Wales • University of Warwick • University of Washington • University of Zurich • University of Virginia • University Victor Segalen • Virginia Commonwealth University • Wake Forest University School of Medicine • Washington University in St. Louis • Wayne State University • Wenzhou Medical College • West Virginia University • Western Michigan University • Westfälische Wilhelms-Universität Münster • William Harvey Research Limited •

DMT A/S
Skejby Science Center
Skejbyparken 152
DK-8200 Aarhus N
Denmark

Tel.: +45 87 41 11 00
Fax: +45 87 41 11 01

www.dmt.dk
sales@dmt.dk
support@dmt.dk

DMT-Asia Ltd.
Rm 2402B, Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong S.A.R.
P.R. China

Tel.: +852 6621 8337
Fax: +852 3020 7554

www.dmt-asia.com
sales@dmt-asia.com
support@dmt-asia.com

DMT-Asia (China office)
Rm 28C, No. 8 Dong Fang Road
Lu Jia Zui Financial District
Shanghai 200120
P.R. China

Tel.: +86 (0) 21 5425 1330
Fax: +86 (0) 21 5877 0063

www.dmt-asia.com
sales@dmt-asia.com
support@dmt-asia.com

DMT-USA, Inc.
201 East Liberty Street
Suite 6
Ann Arbor, MI 48104
USA

Tel.: +1 770 612 8014
Fax: +1 678 302 7013

www.dmt-usa.com
sales@dmt-usa.com
support@dmt-usa.com

840MD/04/2013